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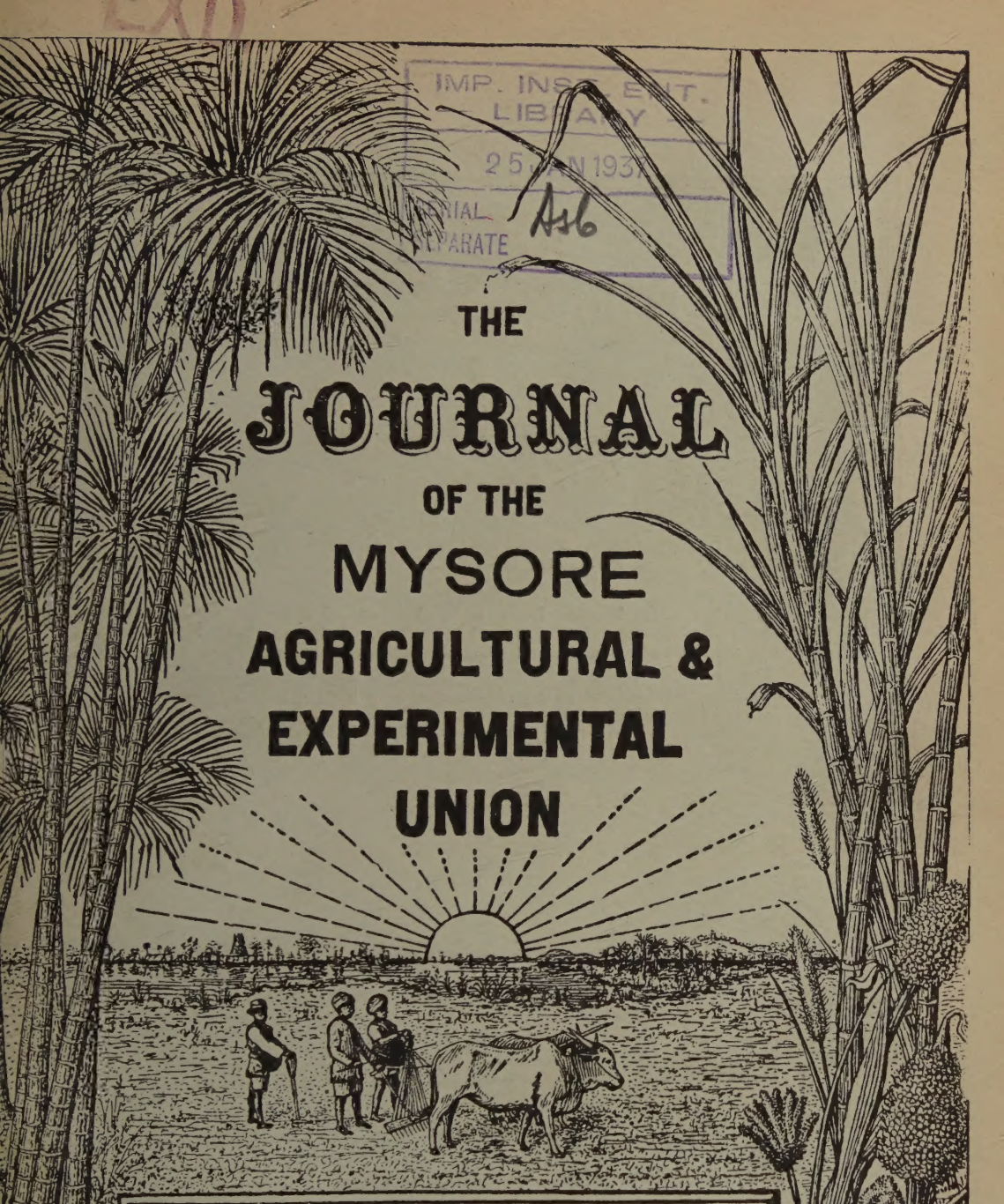

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Vol. XVI] [No. 2

Orange Growing in the Malnad

By

E. Studer, *Coffee Planter*

I am glad to accept the invitation of the Secretary of the Mysore Agricultural and Experimental Union to write a note on my personal experiences with regard to orange cultivation, as it may open the eyes of many to the great possibilities of the Citrus Industry in Mysore and in the Malnad in particular, and also to show it as one of the possible cures for unemployment amongst educated classes, which is so prevalent in these days.

Location.—I have opened two orchards, one mile apart, near a main road, in the Arehalli Hobli of the Belur Taluk. One, Alur, is 21 acres planted, the other Navilahalli, is 10 acres, also planted. Both will be opened more until Alur is 56 acres and Navilahalli 25 acres.

The annual average rain-fall is 45 inches at Alur and 55 at Navilahalli. Both are of a red soil type with *ramakallu* which is said to be good for orange growing. Alur is a richer loam than Navilahalli; both have a north and northeast facing. No irrigation has been done; the monsoon rains provide all the necessary moisture. The plants range from one to five

years in age. They are all of the Coorg or loose-jacket type, with a small exception of Mediterranean Sweet and a few lime-trees.

Selection of Type.—My object was to supply the general market with an easily-grown and well-known fruit, from indigenous trees, well acclimatized to our conditions and less susceptible to disease. The luxury trade in citrus exists on a small scale only and could be easily swamped if general planting of the Malta or Navel oranges were adopted. Besides, these are of a highly-bred and specialized type, with all the difficulties inherent to very sensitive specimens of the vegetable or animal kingdom. The Coorg is a heavy bearer under normal conditions, well-established trees giving over 2,000 fruits in one crop and even as much as 5,000; the exotic varieties can produce only half that at the most, and very often much less.

For the first plantings, seedlings of Yemmedoddi, Aldur and Virajpet were procured. They were kept in nursery for one year and transplanted at two years' old from seed. A few Gooties were also tried as they are said to grow more quickly. In actual practice, seedlings did equally well. Now I obtain seed from well-known trees and grow my own seedlings. It may not be cheaper but gives better results. One can easily discover the difference in the orchard between the seedlings of different origin.

Budding is much advertised but I hardly think it will improve the Coorg type. It has been remarked by several writers that the Suntara orange, to which the Coorg is closely allied, I think, grows true to type from seed and shows few variations. I have tried budding on some stock but did not succeed. My difficulty has been to find good bud-wood of over one year old from Coorg trees. I am told this difficulty is not felt in Bangalore, probably the buds there swell more due to the heat and the thorns may be less numerous.

Planting.—For planting, spacings of 20′ × 20′, 18′ × 18′ and 15′ × 15′ were tried. The last has been finally adopted,

though it may be on the small side in very rich soil. Two-year old seedlings are put in pits of 2′ × 2′ × 2′ previously dug and filled, on a cloudy day, the earth well firmed round the seedlings and stakes tied to them. The seedlings planted below the nursery mark are not successful. I attach much importance to good planting. The month of August is favourable for that operation here, as the heaviest rains are over by then.

Cultivation.—Two ploughings and one or two cultivations are given throughout the orchards, every year, apart from digging round the plants to keep the soil clean. Ploughing is given to improve the texture of the soil, aerate the roots, and keep a larger store of water in the subsoil against the dry season. I consider cleaning round the plants an essential operation.

Manuring.—The Navilahalli orchard has received one application of well-decayed cattle manure, every year, distributed round the plants, in a radius slightly larger than that of the branches. An extra application of guano, four ounces per tree, was given last year. Alur has had no manure except for an experimental dose of superphosphate for some trees which have responded well. The last clearing has received one ounce of sulphate of ammonia per tree, in two applications, soon after planting. The difference in the manurial treatment between the two orchards is due to the difference in the soils.

Apart from shaping the trees and keeping the bottom of the stems free of branches and suckers, no pruning has been done. The Coorg orange does not require much pruning; it is enough to keep it clean and shaped. Topping has been tried without success; the topped trees shot up again almost immediately.

No irrigation has been resorted to, even for the young seedlings, but for the first hot-weather season leaf-mulch has been given.

Pests and Diseases.—The citrus family has many enemies, but fortunately none of them capable of inflicting fatal results, if watched properly.

Amongst the insects, I have found caterpillars very troublesome in the early stages. Two kinds were noticed: the orange-dog and a larger one, green, with white bands. If not checked in time, they will defoliate completely a small seedling. Children hand-pick them.

The twig-borer is not uncommon. The affected branches are cut back to the unaffected portion and burnt; in some cases, the grub had gone right down to the stem and killed the young plant. The stem-borer has not made its appearance yet. It is present in the district but favours what we call sweet lime (The Malta Orange).

Amongst the scale insects, green-bug, with the following sooty mould, is seen occasionally. Honge oil has been tried. The cottony cushion scale, the mealy bug and the aphis have been seen but are very minor pests.

Fungus in a damp climate is always abundant, particularly when there are breaks in the rains; alternations of rain and sunshine or heavy mist and sunshine have brought mildew here. Gingelly-oil-bordeaux is effective but must be repeated as mildew attacks the new growth, and orange trees are flushing practically throughout the year, except for small rests.

Frenching has been noticed rarely; I wanted to try zinc sulphate but could not procure it locally. Die-back has also shown itself in newly planted individuals; it was imported from the nursery. The Government Mycologist has found its parasite, on specimens sent, but not the fungus. Only a few cases were detected.

Injuries done to trees by cattle, pruning, bad treatment, etc., have resulted in a few cases of bacterial trouble which I cannot identify; they have been treated with copper sulphate paste and painted over with white lead. I may remark, in this connection, that cattle, as a rule, do very little damage to

citrus trees and I have not found a barbed wire fence necessary, though I have made a live fence of sour orange and silver oak, the latter acting also as a wind-break. And since these are personal notes, I may be allowed to add to the list of citrus pests and enemies here, the enthusiastic admirers who have paid me the compliment of imitation to the point of stealing freshly-planted seedlings and supplies. Several hundreds have disappeared in this way and have never been traced.

Open Planting, Clean Cultivation.—This experiment has proved the fallacy of the alleged necessity of growing citrus under shade in the Malnad and I am glad to say that the open method of planting has been adopted locally after watching my results. In this way, land that was not thought fit for fruit planting is taken up, to the benefit of everybody.

It is quite possible that the fruit may require protection against sun-burn, in certain expositions. I am watching that point.

Another result has been the realisation that clean cultivation is necessary for good results in the orange orchards. I was strongly criticised locally on both points, in the beginning, but in spite of his conservatism, the ryot goes by results and is amenable to conviction by proof.

Results and Prospects.—Now, one may ask, what have been the results obtained so far and what prospects lie ahead?

The first plantings (August, 1931) have given some fruit already last year, but these were from Gooties; this year, however, the fifth from planting, seedling trees have also come into bearing with about 20 fruits each, at Alur. The growth of the trees has been very good, both in the height and girth, specially in the better soil, and with my own seedlings. Regular cropping is expected from 1938.

In my estimates, I have allowed 500 oranges per tree and Rs. 5 per thousand sale price on the spot. At the spacing of 15′ × 15′, 190 trees go to the acre which should give a gross return of Rs. 475 per acre. The expenditure may vary greatly but need never reach more than Rs. 100 per acre.

Trees are given on contract in these parts, at the rate of from Re. 1 to Rs. 3 per tree, the contractor watching and keeping the crop. This is for orchards which receive very little care and the upkeep of which does not come to more than Rs. 10 an acre, very often less.

I have been asked whether there was no fear of over-production. I don't think so, as cheap fruit will always be very popular in India and, with proper organization and distribution, the industry can hope to grow healthily for many years to come, tapping the north and northwest areas outside Mysore. But, of course, in this, as in everything else, the first comers will reap the best results.

Cure for Unemployment.—I alluded, at the beginning of these notes, to unemployment amongst the educated classes. All authorities on citrus-growing are unanimous in saying that it requires an educated man to conduct it. I believe it cannot be left safely in the hands of the ordinary ryot. But, judging by the above figures, if a man, instead of spending Rs. 3,000 on the University and professional education of his son, sunk that amount in a small orchard of, say, ten acres, he would supply him with independent and decent means for the rest of his life and for his grandsons' life as well, provided the said son agreed to supervise the orchard personally.

There is scope here for the capitalist also. A 500-acre orchard would be a wonderfully attractive proposition, given the proper man to manage it.

Desiderata.—The Citrus Industry is already well established in the Malnad and signs are not wanting to show that it is expanding. I know of several owners who have planted one, two or more thousand orange trees in the last three years and many ryots are also doing the same on a smaller scale. To help these efforts, we require, firstly, a survey of the existing orchards, of their markets and the value of their crops both in the market and in the orchards. Together with this survey, we require a Citrus Plant Breeding Station, in the

Malnad, to study, under local conditions, different types of the Coorg orange, especially as regards their cropping time. A variety cropping in summer time or early in the west monsoon would increase the value of the fruit five-fold. I have also experimented in that line with some results, but on too small a scale. The study of the keeping qualities of the Coorg orange is also highly desirable. If this orange kept as well as the Malta or tight-jacket orange, we could easily compete in the English market.

And when we really get going, a Growers' Society will keep a healthy tone in the market and may become a sales organization for the greatest benefit of the Malnad.

Tissue Vaccine Against Rinderpest

(A Resume of Literature)

By

G. N. Sreekantiah, G.M.V.C., *Veterinary Inspector*
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For over a century and a half, in fact, ever since Rinderpest became recognised as a dreadful scourge of cattle population, various methods of protecting cattle against the disease are being practised from time to time. From the last decade, the Serum-Simultaneous method of inoculation is in vogue in India to establish an active immunity. Edwards, after completing his experiments successfully on Sero-Virus method of inoculation, took up the work of eliminating the piroplasms from the bull-virus. For this purpose, he passed the bull-virus through goats and by about 30 passages he found that the virus got attenuated to an appreciable degree. Taking advantage of this result, he recommended the goat-passaged virus in place of bull-virus for serum-simultaneous method of inoculation. Major Sterling (1932–33) in Central Provinces and Major Simpson in Mysore tried this method with success and it is being adopted in most of the provinces in India.

A step further is advanced in the field of Rinderpest by using Tissue Vaccine. Various workers tried vaccines prepared from blood and other organs removed from animals affected with Rinderpest. They succeeded in getting good results with the vaccine prépared from the spleen. Large percentage of virus is contained in the cellular elements of spleen, which fact is also true of other virus diseases. On this basis, Vallee and his colleagues (1925) prepared a vaccine for foot and mouth disease from the spleen of the affected animal and claim to have immunised the animals against foot and mouth disease through this vaccine. Lebailly (1927), Dunken and Laidlaw (1926) prepared a vaccine for distemper from the spleen of the affected ferrets and dogs.

The earliest attempt to prepare a tissue vaccine against Rinderpest was that of Kakizaki in 1918, who claimed that he had successfully attenuated the virus in Spleen tissue by the action of glycerine. He believed that he was able to retain the antigenic value in the tissue vaccine for over a year by preserving the same at 0°C. Kakizaki, Nakanishi and Oizumi (1926) recorded a fall in the antigenic value as the temperature was raised.

Boynton, working in Philippine Islands as long ago as 1918, prepared a vaccine by using glycerine and 0.5 per cent. phenol and heating for three hours at 42°C. From field observations made on the use of his vaccine, he claims that his product remains potent for at least three years.

Curasson and Delpy (1926), inspired by the success claimed by Vallee and his collaborators in the preparation of a vaccine against foot and mouth disease, conceived the idea of preparing a spleen vaccine against Rinderpest by attenuating the virus in this tissue with 0.2 per cent. of formalin. This vaccine was used 48 hours after preparation. The animals that received big doses, from 12 to 100 gm., of vaccine were said to have developed immunity.

Daubney (1925–27) (1928) prepared the formalised spleen vaccine with different dilutions of formalin and incubating at various degrees of temperature. He recorded that

higher concentrations of formalin (1 : 250 to 1 : 1000) destroyed the antigenic properties of vaccine in short periods of 48 to 72 hours, whereas weaker concentrations (1 : 2000 to 1 : 10000) were found to be invariably associated with heavy bacterial contamination.

Long before the work of Curasson and Delpy, Kelser (1927) and later Kelser, Youngberg and Topacio (1928) modified Boynton's method which required 6 to 7 months' preservation in refrigerator before it could be mature for use, to the extent that the vaccine could be used within 2 to 3 hours after preparation.

In the preparation of all the above-mentioned spleen vaccines, the material is exclusively of bovine origin. Encouraged by the results of his experiments on attenuating the virus by passing through goats, Edwards hoped to prepare a tissue vaccine from goats. This work was taken up by Haddow at Muktesar with success. Kerr and Menon (1934) adopted this method and prepared a vaccine from the spleens removed from Rinderpest-infected goats at the height of reactions. They claim that the vaccine has got keeping qualities up to 30 days at 45°F. and 7 days at room temperature. By this vaccine, 10,764 heads of cattle including buffaloes are said to have been inoculated with promising results. The advantages they claim for the vaccine over goat-adapted virus are that a greater quantity (*i.e.*, about 4 times) of vaccine than of virus can be got from a goat and that the vaccine can be preserved for 30 days, whereas the virus can be kept in cold storage for only about half the number of days.

Achar (1933–34) recording the work of Nayar and Kuppuswamy states that a sample of vaccine was prepared in the Institute according to the technique of Kerr and Menon and was tested on susceptible cattle. The vaccine was preserved in cold storage in five lots, for 3, 16, 34, 59 and 90 days respectively, and batches of buffalo calves and goats, each batch consisting of three animals were infected with the vaccine. Goats were used for confirmatory tests and

the buffalo calves as test animals for vaccine. The first four batches received 1 c.c. of vaccine and the fifth batch received 5 c.c. each. By a careful study of the reaction it was ascertained that the vaccine preserved at 32° F. for 34 days was potent enough to establish an immunity of 100 per cent.; whereas the vaccine preserved for 59 and 90 days has given only 33 1/3 per cent. immunity. The reactions in goats were of definitely suggestive nature for the presence of the virus. Two out of 14 control animals died of Rinderpest, 8 reacted typically; whereas none of the test animals (buffalo calves) showed any reaction. In all respects, our results agree with those of Kerr and Menon (1934).

Another noteworthy advantage of this vaccine over goat-adapted virus appears to be that the former might be used alone on buffaloes without serum without any untoward result.

Recently the vaccine is being issued to the field worker in the form of tissue itself from Bengal and Muktesar Laboratories. The advantage of this method is that no preservative is necessary. The spleen is cut into small pieces, dried, put in sterile ampoules, sealed and preserved in cold storage. These ampoules are despatched to the field worker who makes an emulsion with normal saline solution and uses for inoculating the animals.

The technique described by Kerr (1925) is as follows:— The spleen of reacting goats is removed and cut into pieces of 1 gm. in weight which are placed in glass ampoules, sealed in a flame and stored at 45°F. This material is kept satisfactorily for 30 days at 45°F. and for six days after removal from cold storage. Potency is reduced on the 7th day and is rapidly lost on exposure to sunlight or excessive heat. The infected spleen is used as a 1 per cent. emulsion in 0.5 per cent. physiological saline solution and is given in doses of 1 c.c. to cattle and 0.5 c.c. to buffaloes.

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A Short Note on the Scope for Improved Method of Jaggery Boiling

By

Y. Narasinga Rao, *Retd. Assistant Commissioner*

I had the assistance of the Agricultural Department in milling the sugarcane and preparing jaggery at my village in the Yelandur Jahagir (Mysore District), during the last season. The milling commenced in the middle of January and closed early in March. Besides my own mill, the Departmental mill, which I had borrowed from the Chamarajanagar Depot, had also been set up chiefly with a view to demonstrate the higher crushing efficiency of the mill recommended by the Department.

Two furnaces similar to that used at the Hebbal Farm were constructed by the Departmental man. The furnace was of a new pattern to that area, and the need for extra fuel was almost entirely dispensed with as the furnace mainly depended upon dried megass and cane trash.

The work was continued for over three months affording me a good opportunity to study the milling methods in vogue at Agara, where I stayed. This is a large village in the Yelandur Jahagir about 3½ miles south of Kollegal and about 50 miles from Mysore.

The fact that the furnace constructed at my milling house required no extra fuel very strongly appealed to the ryots

in the neighbourhood. Most of the important cane-growers visited my mill-house and evinced much interest in inspecting the work and understanding the details. As particular care was taken to remove the muck thoroughly, the jaggery came out to be very clean and to have good colour. This was particularly interesting to them.

An opportunity was thus given to me to discuss with the ryots details about sugarcane cultivation from various aspects. I could see that there was considerable avoidable wastage and loss suffered by the ryots by not adopting improved methods in milling canes and preparing jaggery. Surely, the ryots of this locality, who are able to raise very good crop by careful cultivation, ought to be able to reduce this loss to the minimum by having recourse to improved methods in the preparation of jaggery.

Cropped Area.—The *atchakat* under the Agara tank is nearly 2,000 acres and about 120–150 acres are annually planted with sugarcane. For the purpose of this note, an average of 125 acres is taken as the extent of sugarcane area per year and 9,000 setts as the number planted per acre; or the annual crop of the locality may be said to consist of about 11 lakhs of pits or setts, as it is commonly known. It is customary here to plant in pits, 1½ feet in the row and from row to row.

(1) *Milling.*—The three-roller mills of the ordinary type are used, most of them having $9'' \times 7''$ rollers. As per estimate of the Agricultural Inspector, the juice expressed by them amounts to 58–60 per cent. of the weight of the cane, whereas the extraction by the Madurai and Globe mills (latter being the mill purchased by me) was over 70 per cent. Loss due to the lower crushing power of the mills used by the ryots works out to 1/6 of their total produce. Taking 240 maunds as the average yield of jaggery per acre which is not a high average for this area, since nearly a fourth of the entire area yields 350 to 400 maunds per acre, the loss due to inefficient mill seems to be 5,000 maunds. This loss in money

value will be Rs. 3,750 or, say, Rs. 4,000 in round sum, jaggery selling at As. 12 per maund, working up to Rs. 32 per acre, which is a good profit worth striving for.

2. *Furnace.*—Usually, brushwood fuel is brought from the forest and stocked before commencing milling, on the basis of 3 cartloads per 1,000 pits. The total cost on this account amounts to Rs. $125 \times 9 \times 3 \times 1^1/_2 =$ Rs. $125 \times 40^1/_2$ = Rs. 5,062-8-0 or Rs. 5,000 in lump sum.

3. *Quality.*—No attempt is made to remove muck in the local method and every time the hot ash is watered and every time the wind blows, the juice pan receives a fair quantity of ash. Further the pans are not systematically cleaned every day. Large quantities of low quality lime solution are added to every panful of juice. All these go to make the jaggery black in colour and low in quality. If muck is removed by using the skimming ladle, good quality lime is added in suitable quantities and other possible precautions are taken to prevent ash and dust getting into the pan, jaggery of good quality and colour can easily be obtained. In terms of money, this means at least 2 as. more per maund. For the total area it means Rs. $125 \times 240 \times {}^1/_8 =$ Rs. 3,750, or Rs. 4,000 in round sum. It has to be noted that this increase does not involve any material additional outlay.

4. *Transport Charges.*—Small-sized cubes of 12 to 14 tolas by weight are largely in vogue in this area. Fifty such cubes are packed in a bundle and sixty such bundles form a cartload. In terms of maunds, a cartload takes in 33 to 34 maunds of 45 seers. If, on the other hand, cubes weighing 36 to 40 tolas each as adopted by me are introduced, each bundle consisting of 30 moulds would weigh 1 maund and 60 such bundles could be loaded in a cart. (As a matter of fact, 75 bundles were being loaded in the carts I was sending from Agara to Bangalore.) The freight per maund would be nearly double by using the small moulds. Taking 2 as. as the freight per maund to the nearest large market for larger cubes (it is actually a little less), as the producer and not the consumer has to bear the extra freight, in respect of

smaller-sized cubes, the loss on this account would amount to $125 \times 240 \times {}^{1}/_{8}$, or Rs. $125 \times 30 =$ Rs. 3,750, or Rs. 4,000 in round numbers for the whole area.

The total of the four items mentioned above amounts to Rs. 4,000 *plus* Rs. 5,000 *plus* Rs. 4,000 *plus* Rs. 4,000, that is, Rs. 17,000. If it is noted that the total yield for the village is about 30,000 maunds and the local price is between 10 to 12 annas per maund, as at present, bringing the value of the entire produce to less than Rs. 22,500, what an additional income of Rs. 17,000 will mean to the ryots needs no stressing. The Department, by taking necessary measures, can effect the improvements suggested above within 3 to 4 years.

There is another important point requiring attention. Due to good growth, a fair portion of the crop lodges on the ground causing material loss in the quality of a good proportion of the jaggery yield.

Improvements in methods of cultivation, introduction of better varieties of cane and the adoptation of improved methods in making jaggery and in transport are sure to improve the sugarcane industry in this fertile corner of Mysore.

Plantain Cultivation under Vani Vilas Sagara

By

S. V. Haridas, L.Ag., *Agricultural Inspector, Hiriyur*

Locality and Climate.—Plantain cultivation as practised in Chitaldrug District, under the Vani Vilas Sagar Reservoir, is described in this article. The District is a dry one, with an annual rainfall of only 14 to 18 inches. The crop depends on an intermittent supply of irrigation water from the Reservoir, with a flow period of 5 days followed by an off period of 10 days, every time. Jeshta, Ashada and Sravana (latter half of May, June and July), are generally the months during which strong winds blow in the locality and plantains require protection. Suckers planted in June grow up and bear inflorescence in an year when they are liable to severe damage. On account of this, planting the suckers in

June is looked upon with disfavour. Many cultivators prefer to plant their crop in July and August, so that the crop may escape the damage referred to above as the weather by that time would have settled down to normal conditions and the least damage is caused to the ripening bunches.

Soil.—The soil is generally red loam, with a large mixture of gravel of different sizes with a tendency towards being coarse, gravelly loam. Patches of clay loam also are sometimes used for plantains. Stony soils, alkaline soils and kankars are usually avoided. The red gravelly soil generally gets hard after every irrigation and it is felt necessary to irrigate once in 8 days to keep the soil in soft and fair tilth.

Varieties.—The varieties of plantains grown by the farmers in the tract at present are Poovan, Pachanadan, Rasabale, Puttubale and Kalyanbale. Poovan is a variety from Salem, and it is the one which is commercially important here, at present. It is popular among poorer classes of people and finds a ready sale. The other varieties are rather rare and a few suckers are often grown in the gardens to meet special demand or for domestic use. There are generally more fruits in Poovan than in any other and, on this account, it is popular. More than 150 to 200 fruits are borne on a bunch and the gross income per acre from the Poovan, therefore, is greater than from others. But the quality is inferior to that of other varieties and the prices also are lower per dozen. In this article, the cultivation described applies to the Poovan variety.

Preparatory Cultivation.—Preparation of the land intended for the year's planting begins in May or June. Usually, the plot is ploughed four times with the country plough. Stones are picked and heaped separately, bunds are cleared and the soil is allowed a sufficiently long time for aeration.

Planting.—Suckers of 3 months' growth are usually selected for planting. The height of each sucker at that stage will be 12″ to 15″. After the suckers are separated from the mother plant, the roots and the top are trimmed to the

required length and the planting portion is preserved in a cool place till required.

The plot is flooded once and locations for planting are marked about 7½ feet from one to the other either way, by the use of line ropes. Suckers are pressed into the soft soil at the points of intersection. The second irrigation is given after 8 days.

Seven hundred and fifty suckers are planted in an acre. The cost of suckers works up to Rs. 11-4-0, at Rs. 15 per thousand. Labour for planting is employed on a contract system at 3 annas for planting a hundred suckers. The cost of planting is Rs. 1-8-0 an acre and usually 3 men and 2 women finish the work.

Inter-cultivation and Manuring.—About 13 days after planting, the plot is formed into beds. This employs 12 men to the acre, and is also done on a contract basis at Re. 1 per 100 beds of $7\frac{1}{2}' \times 7\frac{1}{2}'$. The land is irrigated once a fortnight, roughly. The suckers take 1½ months from the date of planting, to sprout. Meanwhile, the plot is fenced and drains are opened all round. When all the suckers have sprouted, drains are opened within the plot. For opening these drains, they generally employ about 32 men at about 6 as. a day, and the total cost will be about Rs. 12 per acre.

The garden is manured in the third month after planting. The usual quantities of manures applied are 15 cartloads of Farm-yard manure and 75–80 maunds of oil-cake. A cartload of Farm-yard manure costs from Rs. 1-4-0 to Rs. 1-8-0. The oil-cake used is a mixture of Honge (*Pongamia glabra*), Castor (*Ricinus communis*) and Bevu (*Melia azadarichta*) cakes. It costs on an average about Rs. 25 a ton. The total cost of manuring would generally be about Rs. 50.

The soil in the garden is dug just before it is manured. It requires 10 men to dig and 8 men to apply the manure over an acre. In some cases, Farm-yard manure is applied in the third month after planting and the oil-cake in the fourth and fifth months, but the more widely prevalent opinion is that

1. A plantain garden newly planted

2. A garden in its full growth

3. A full grown plantain bunch

it is better to apply the Farm-yard manure and the oil-cake together.

When plants are six months old, the dry leaves are tied up by about 8 women and suckers also are removed simultaneously by 2 men following them.

The soil is dug once in every three months. There are five diggings during the course of the first crop. While digging, suckers also are removed. In the ninth month, when the plot is dug, drains are cleaned and deepened.

It is from the suckers appearing in the twelfth month of the initial planting that the second crop is taken. For this purpose, only one sucker is allowed to remain close to each mother plant. About this time, the plants will also be bearing bunches and they are supported by props, if they are found to be slanting on account of the weight of the bunches and the force of the wind.

The early bunches are harvested in the fourteenth month. The harvest continues till the seventeenth or eighteenth month. About 50 per cent. of the bunches are ready by the fifteenth month and the rest follow a little later.

Preparation for the second cropping begins in the fifteenth month, when the land is dug well and the drains are attended to. In the eighteenth or nineteenth month, the garden is manured with the same kind and dose of manures as given at first. The usual round of stirring the soil and removal of suckers continuing, the second crop develops bunches in the twenty-second month. The harvest from this crop lasts from the twenty-fifth to the thirtieth month (all counted from the initial planting).

Harvest and Treatment.—The bunches harvested are put into a heap in the evenings and covered over with litter and pasted all round with earth, leaving a small hole in the covering to force smoke through. A pot with a hole is used for smoking and smoke is blown through this hole into the heap. Then the heap is left intact overnight. The bunches may be so treated in the morning, if they have to be carted to the market

during the night. When the heap is broken up to be loaded into the carts, it is usual to separate the 'hands' of fruits from the big bunches in the case of the Poovan variety. The other kinds of plantains are not divided into 'hands'. Smoking of the bunches is said to impart a fine yellow colour to the skin of the fruits, thereby helping to attract customers in the market. The bunches are carted to the market place, well packed with dried leaves, etc., so that the plantains may not be bruised.

Markets and Prices.—The usual market for Poovan variety of plantains grown in this locality is found at Challakere, Chitaldrug, Hosadurga, Aimangala (Hiriyur Taluk) and Sira. There are no middlemen dealers for this commodity in this locality. Growers purchase bunches from one another to make up a cartload or two to market. Three years back, growers used to send their produce to Davanagere and Rayadurga, places more distant than those enumerated above. Unfavourable rates and increased cost of transit have acted as a set-back for this enterprise. The price of plantains is always fixed according to sizes and colour of fruit. On an average, each bunch fetches a price of seven annas.

The majority of the plantain-growers here are settlers from Coimbatore and Salem in the Madras Presidency. The conditions obtaining in their home districts are said to be very favourable to this industry. There are dealers there, it is said, who advance to the growers Rs. 100 an acre in the shape of manure. No interest is charged on this value but the client is bound to sell his produce to the dealer. A commission of six pies per bunch is charged for this and the services at market. The realisation is said to be eight annas per bunch. The flowers, leaves and fibre are also said to yield an income of Rs. 50 an acre in those districts. They neither find a market in this locality; nor are here men to advance money for the cultivation of plantains.

Cost of Cultivation and Realisation.—The various items of the cost of cultivation and realisations are given below. They are approximate figures arrived at from local enquiries and not figures worked out from specific cultivation sheets,

which, indeed, the growers do not maintain. It is, however, believed that the figures given here present a fair picture.

Cost of Cultivation

Expenditure per acre

Sl. No.	Items	Cost
	I Crop	Rs. A. P.
1	Ploughing 4 times at Re. 1 a ploughing for 8 days	8 0 0
2	Harrowing 4 times Re. 1 for 4 times	1 0 0
3	Drains 3 feet deep, 32 men at 6 as.	12 0 0
4	Fencing (Contract)	8 0 0
5	Cost of 750 suckers at Rs. 15 a 1,000	11 4 0
6	Planting (2 women and 3 men at 3 as. and 6 as. respectively)	1 8 0
7	After 12-14 days of planting, formation of beds at Re. 1 for 100 sub-plots	4 0 0
8	At 3rd, 6th, 9th, 12th and 15th months digging. 12 men at 6 as. each time	22 8 0
9	Cost of 15 cartloads of manure at Re. 1-8-0 a cart	22 8 0
10	Cost of mixed cake at Rs. 20. Cart hire Rs. 5 for 75-80 mds.	25 0 0
11	Powdering of cake Rs. 4 and application in 2 doses at Rs. 3 a time	10 0 0
12	6th month tying of dry leaves, 8 women at 3 as. each	1 8 0
13	Removal of suckers in 6th, 9th, 12th and 15th months, 2 men at a time at 6 as. each ..	3 0 0
14	Deepening of drains in 9th or 10th month, 32 men at 6 as.	12 0 0
15	Watering and general work at Re. 1 a month for 15 months	15 0 0
16	Assessment for 15 months at Rs. 5-8-0 a year	6 14 0
	Total ..	164 2 0

Sl. No.	Items	Cost
	II Crop	
1	Cutting of old stems, 4 men at 6 as. ..	1 8 0
2	3 diggings, 18th, 22nd and 26th months at Rs. 5 a time	15 0 0
3	Manure and manuring as above	57 8 0
4	Removal of suckers at 12 as. a time, 3 times before digging	2 4 0
5	Deepening of drains in 18th or 19th months ..	12 0 0
6	Fence repairs	2 0 0
7	Irrigation and general work	15 0 0
8	Assessment for 15 months at Rs. 5-8-0 a year ..	6 14 0
	TOTAL ..	112 2 0
	GRAND TOTAL ..	276 4 0

Realisations

	Rs.	A.	P.
I Crop 700 bunches at 7 as.	306	4	0
II Crop 700 bunches at 7 as.	306	4	0
II Crop plaintain suckers 1,000 at Rs. 15 ..	15	0	0
Gross receipts ..	627	8	0
Net income in 3 years	351	4	0
Or for 1 year	117	1	4

Interest on capital and supervision charges are not taken into account in the above.

Some growers try to take a third crop from the same planting, but that is a poor crop invariably. There is a marked deterioration in the quality as well as quantity of the produce. The recent move is to remove the planting completely after the second harvest itself.

SELECTIONS

The Effect upon the Yield and Quality of Tobacco of Transplanting Seedlings of Different Ages

BY

Donato G. Dalupang

The work was conducted in the College of Agriculture Experiment Station, from June 1932 to May 1933 (Philippine Islands).

One of the standard native varieties in the Cagayan Valley, N-45 Alafug, was used in the study.

There were four experimental cultures:—

Culture No. 1.—51-day-old seedlings.
Culture No. 2.—44-day-old seedlings.
Culture No. 3.—37-day-old seedlings.
Culture No. 4.—30-day-old seedlings.

The cultures received the same treatment or care from seedling stage to matured plants.

Fifty plants were taken at random from each culture before harvesting the leaves, and these plants were studied according to the following: (1) height of the individual plant; (2) length and width of the lowest, standard and upper leaves; (3) number of the sand, standard and top leaves; (4) texture, colour, surface, venation, petiole, position of leaves on stem and percentage of injury caused by mosaic, by tobacco-wilt disease, and by tobacco-borer infestation.

The following results were obtained by the author:—

(1) At maturity, there was an ascending order in the height of the plants from the older to the younger seedlings.

(2) The younger seedlings produced longer and broader leaves than the older ones.

(3) In general, the number of standard and top leaves produced from 30-day-old to 51-day-old seedlings decreased with increase in age.

(4) The plants matured in the descending order from the older to the younger seedlings.

(5) The 30- and 37-day-old seedlings gave higher yield of dry leaves than either the 44- or 51-day-old seedlings.

(6) In quality of leaves produced, the 30-day-old seedlings ranked first, the 37-day-old, second, and the 44- and 51-day-old, third.

(7) The 30-, 37-, and 44-day-old seedlings produced leaves that were of the same gumminess, pubescence and thickness. The 51-day-old seedlings produced thicker and slightly gummier leaves than any of the other three cultures.

(8) The age of the seedlings did not affect the character of the surface, venation, petiole, position or arrangement of leaves on the stem.

(9) The plants of 51-day-old seedlings were the most susceptible to mosaic and tobacco-wilt disease and to tobacco-borer infestation.

(10) The author concluded from his study that on the whole, the 30-day-old and 37-day-old seedlings produced larger yields and a better quality of leaves than either the 44-day-old or 51-day-old seedlings.

—*Abstract by Bonifacio Puntalba, "The Philippine Agriculturist."*

Vol. XXIV, No. 10.

The Effects of the Seasons upon Plants

The *Illustrated India*, of the 19th April 1936, has an article on "The Hindu Healing Art" by J. N. Chakravarthy, B.Sc., in the course of which appears the sentence, "The Hindu physicians pay special attention to the effect of the seasons upon plants, the various localities and circumstances in which they develop their distinctive properties, the influence upon them of the Sun and the Moon, and the exact period at which they should be collected."

A paragraph from "Food, Farmer and Future," by Prof. Henry E. Armstrong, F.R.S., appearing in *Nature* of Saturday, October 12, 1935, may be quoted. It runs:—

"A problem to be enquired into is the cyclic variation with the year in grass and other green foods supplied to cattle. The plant must change its character in passing up to the climax of its growth and thence down to maturity. Milk must be correspondingly affected. At present all that we know is, that some of the shortcomings in winter-food may be met by rationing cattle with summer-grown grass, cut young and immediately dried with special care. In an experiment which I was instrumental in starting at Christ's Hospital, three winters ago, six cows out of a herd of thirty-six were fed with such grass, grown, cut and dried under the superintendence of Sir Frederick Keeble, at the Zealot's Hill Farm of Imperial Chemical Industries, Ltd. Throughout the winter, the six remained sleek and gave a milk of summer character, whilst the rest of the herd fell off as usual, giving an ordinary poor winter milk. Similar results have since been obtained elsewhere. We

may hope that, some day, winter conditions may be overcome by justifying the practice of the Laputan Philosophers."

Some extracts from *Bulletin* No. 190, May 1935, of Georgia Experiment Station "On the Iodine content of some Georgia vegetables and water as a factor in its variation" by K. T. Holley, T. A. Pickett and W. L. Brown also afford parallel reading with the above quotations.

"Since the discovery of relatively large amounts of iodine in the thyroid gland, there has been a growing interest in its relation to public health. The evident relation of iodine to the health of livestock has also served to emphasise its economic importance in that industry. Iodine determination on soils, foods, feedstuffs, and waters from various areas over the world offer evidence that the occurrence of simple goiter in human beings, hairlessness and weakness in new-born pigs, and other iodine deficiency diseases are directly related to a low iodine content of foods, feeds and water-supplies.

"The results presented on the influence of water-supply on the iodine content of plants indicate that, on the same soil, variation in rainfall alone during the same season or from year to year might cause a great fluctuation in the amount of this element found in the crop. Although many factors no doubt influence iodine absorption by plants, the fact that there was a deficiency of rainfall over the greater part of this State during the potato-growing season of 1930 supports the conclusion that low values obtained on these samples were due in part to the drought during the growing period.

"McLendon and co-workers have pointed out that the potato is generally too low in iodine for satisfactory use as the basis for a survey. A leafy vegetable such as turnip tops would seem to offer much better possibilities.

"Though the incidence of simple goiter in this State (Georgia) is generally considered to be very low, analysis of 109 samples of potatoes showed a very low iodine content, with no apparent variation in samples from different soil types. The leafy vegetables examined showed a fair content of iodine.

"Evidence presented indicates that iodine uptake by at least three vegetables (turnip tops, lettuce and spinach) tends to increase with an increasing water-supply for the growing crop and that the water factor alone may account for great variations in the quantities of iodine found in crops grown under conditions that are similar in other respects. It is suggested that the water-supply is only one of the factors which may have great influence on the iodine content of crop and which may cause seasonal variations."

Soaking Sugarcane before Planting

Two experiments were made to investigate the effect of soaking on the germination of cuttings and on the final yield of cane, both plant and first ratoon. There were five treatments: (1) soaked in a saturated solution of lime; (2) soaked in a solution of lime containing also one pound of magnesium sulphate per 50 gallons; (3) soaked in a complete nutrient solution containing all plant food; (4) soaking in water alone; (5) no soaking. In one experiment, the soaking was for a period of 8 hours, in the other 16 hours.

In both experiments, the yield of cane from the seed-cane that had been soaked in (1) the lime, and (2) the lime and magnesium sulphate solutions, was significantly better than the yield of cane grown from seed-cane that was not soaked and also better than from the treatments (3) and (4). There was no significant difference between soaking in lime solution alone, and lime solution *plus* magnesium sulphate. Hence, preference is given to the method of soaking in saturated lime solution, because it appears to be the simplest. Both experiments were extended to include the first ratoon crops from all treatments. In the plant cane, the increase of yield from the cane soaked in lime water was about 25 per cent., in the ratoon crop about 17 per cent.

The author has made some investigations with a view to finding an explanation of why soaking the seed pieces results both in a better germination and a larger yield of cane. It was first thought that the soaking would initiate a rapid hydrolysis of sucrose, which would speed up the germination process. It could not be shown that soaking had any marked effect on the rate of hydrolysis. It was then thought that the nature of the solution would have some effect on the amount of water absorbed by the seed pieces. By experiment it was found that the pieces actually absorbed significantly more water from the lime solution than from pure water, and this appears to provide the answer to the question. The pieces that have been soaked in the lime solution have absorbed more moisture, and therefore germinate faster when planted; this rapid germination assures a more vigorous growth.

While soaking in the lime solution resulted in an increased percentage of germination, there was still a certain number of failures. By a special investigation it was found that the most uniform stands (lowest percentage of blanks or misses) were obtained when the planting material was taken from young cane, or the top portions of old cane; this means that the best planting material is that containing the largest percentage of invert sugar. Obviously, when such material is soaked in lime water, one condition will be provided that will help to give the best stand and the largest yield.—(*Extracts from "Facts about Sugar"*, 1936, Vol. 30, 12.)

Germination Studies on Sugarcane

Pieces of seed-cane were soaked for 24 to 48 hours in solutions of various materials; among these, extract of ashes and a saturated solution of lime and magnesium sulphate (1 : 50) showed a more favourable effect on the percentage of germination than water alone, and a much better germination than was obtained with unsoaked seed pieces. The more mature parts of the cane-stalk benefited most from soaking. It has been found useful to keep canes standing vertically in drums, with their cut ends wholly immersed in water, to ensure uniform germination of middle and top pieces.

Germination tests with material cut every month and kept in an incubating chamber maintained at 72–78° F., show that the best germinations obtain in monsoon from young canes. High glucose ration and moisture per cent. in cane seem to have a significant bearing. Critical point of moisture percentage in cane buds of Co. 213 was, however, found to be only 40.0. On further desiccation, they lose power to revive even on soaking. Younger buds borne on the top of cane shrivel up and dry more quickly than mature buds, which dry up comparatively slowly. Form and shape of bud and its position on the stalk also influence to a certain extent rate of desiccation. Other points studied show relationship between wax or bloom present on cane-stalks and germination. Varieties having thicker coating of wax show tardier germination under low soil moisture conditions. With high moisture content, differences are, however, less marked.

Capacity of absorption at surface varies with the quantity of wax present and the hardness of rind, and seems positively correlated with high germination. Similarly, rapidity of sugar hydrolysis on soaking seems to indicate whether variety would result in quick germination. (K. L. Khanna, Dip. Agri., Bihar and Orissa, *Bull.* 6 (1934) : abstracted in *Sugar,* Feb. 1936.)

—*The Madras Agricultural Journal,* Vol. 124, No. 4.

Goat Husbandry in Canada

Advantages of Milk Goats

The goat has been appropriately termed the poor man's cow and certainly no better designation could be found to express the economic advantages that are to be derived from the keeping of goats. Milk goats, however, like other live-stock, require proper feeding, care and management and unless they receive the proper care and feed, the results are apt to be disappointing.

The main advantages to be derived from goats are:—

(1) A number of well-bred does may be purchased for a small sum of money, thus assuring, with a proper breeding policy, a continuous supply of milk for family use the year round.

(2) Outlay for buildings and equipment is small.

(3) Most children become attached to goats and soon learn to care for them.

(4) Many people living on small farms or truck gardens near cities and towns can keep a couple of goats without being under the necessity of any large expenditure for feed, thus saving for the most part the cost of the family milk-supply.

(5) Growing children, who learn to love goats and care for them successfully, are likely to make a success with other live-stock.

Points of a Good Milker

If intending to purchase a milk goat, always go to a breeder who has developed a strain of good milkers. See the sire and dam, if possible, and judge by the general excellence of the does and the buck if the breeder has made selections for milk yield. It is also advisable to see the herd milked.

Always look for a doe that is well developed, that has a smart intelligent appearance with a strong back, good feet and legs, and mellow skin and fine hair. A heavy milker will be wedge-shaped: that is, it will be sharp at the withers with compact well-laid-in shoulder-blades, a good spring of rib, a large paunch, good depth of ribs indicating constitution, and good length between the hook and pin bones.

The head of a good milking doe is refined and thoroughly feminine, the eyes are large and bright and the ears well attached. The neck is thin and fits smoothly into the shoulders, an indication of strength and constitution. The body should be well proportioned, but allowing plenty of room for the stomach. The hind quarters should be long and level and the thighs thin, leaving plenty of room for a wide highly-attached udder.

The milk wells should be large and placed well forward. The milk veins should be long and tortuous. The udder, before milking, should be full and well balanced, coming well forward in front and being attached high up behind. After milking, the udder will be thin and elastic, giving no indication of fleshiness. The teats should be placed well apart, having good length so that they may be easily grasped in the palm of the hand.

A mild temperament is highly desirable in milk goats. Nervous goats are usually more difficult to feed and manage, being very often not so satisfactory for breeding purposes.

Breeding

The period of pregnancy for goats is 147 to 152 days. The usual mating season is from September till March, although goats that are stall-fed or goats fed on a heavy grain ration, may have several periods of œstrum during the summer months. Periods of œstrum occur every three weeks. If the doe has to be taken some distance to the buck, it is usually advisable to take her at the first sign of œstrum and it may be advisable to leave her with the buck for a couple of days. As a rule, mating on any date between September and March results in pregnancy provided the doe is healthy and the buck is a sure breeding animal. Doe kids should not be bred until they reach an age of eighteen months. Many goats are undersized, chiefly due to breeding at too early an age.

Kidding

A few days before the doe is due to kid, she should be moved to a box stall, if possible, making the accommodation comfortable in every respect. As soon as the doe has kidded, she should be fed sparingly for a few days. The best of hay in the form of clover or alfalfa should be fed. No grain should be fed the first day. A light bran mash, fed warm, and lukewarm water will be sufficient. After 48 hours, the grain ration may be gradually increased up to a full ration and abundance of succulent feed in the form of roots or cabbage may also be fed.

Rearing Kids

As a general rule, it does not pay to rear goat kids, certainly not the males, unless they are from superior stock and there is likely to be a sale for breeding purposes.

The kids, generally two, are on their feet almost immediately after being born, and if it is not desired to raise them on the doe they should be taken away and put in a box with straw till they dry off, after which the doe should be milked and the kids fed out of a bottle or taught to drink out of a pan. In feeding kids by the bottle, the best plan is to use the Hygiea teat, or similar style, which fits over the usual milk-bottle. The hole in the teat should be enlarged by passing through it a piece of red-hot wire about the size of a fine knitting-needle. For the first week, ¼ pint should be fed four or five times daily; after this, three times a day will do, gradually increasing the quantity. After the second or third week, oat meal water or calf-meal and water warmed, may take the place of part of the milk if the latter is required for household use. Kids soon begin to nibble at brush and hay, and after the third week should also have bran or shorts where they can get it without interference from older goats; they are usually weaned when 6 to 8 weeks' old. If they have been allowed to run with their dam, it is

difficult to wean them as goats become very much attached to their offspring and will allow them to suck until full-grown. Kids which are intended for breeding should be allowed milk as long as possible. If male kids are to be raised for meat, they should be castrated when 10 days to three weeks' old.

Ailments

Though goats are, on the whole, generally free from disease, they occasionally have their troubles, and the following table of diseases, symptoms and treatment should prove useful:—

Ailment	*Symptoms*	*Treatment*
Colds ..	Running at nose and eyes; shivering; staring coat.	Warm housing; blanketing; warm gruel or bran-mashes. Give 2 tablespoons of Epsom Salt with 1 teaspoon ginger.
Bronchitis ..	Similar to above, with quick breathing and dry cough, becoming looser until mucous is thrown up.	As above; give inhalations of turpentine twice or thrice daily by pouring turpentine over a little sawdust in bottom of a bucket, adding boiling water and holding goat's head in the steam, taking care to prevent scalding.
Constipation ..		About an ounce of Epsom Salt in a pint of warm water, and warm bran-mashes.
Chronic Bloat ..	Distention of abdomen.	Teaspoonful of powdered charcoal in feed daily.
Diarrhœa ..		Administer purgative castor-oil, 4 oz.; if diarrhœa continues, give ¼ oz. of prepared chalk in pint of warm water or milk every other day.
Dysentery ..	Thin, slimy, offensive discharges; fever; no appetite; goat becomes weakened and emaciated.	Administer castor oil and feed on good hay or gruel. Give chalk as above, and also 5 grains sulphate of iron twice daily in water.
Internal Inflammation		(See Veterinarian.)

AILMENTS—(*Contd.*)

Ailment	*Symptoms*	*Treatment*
Inflammation of Udder.	Udder swollen, hot and painful to touch.	Rub udder with carbolic oil; milk carefully and well; give 2 oz. Epsom Salt every other day. Apply hot fomentations if udder hard, and dry thoroughly. If kid sucking, take it away and feed by hand.
Sore teats ..		Wounds or scratches on udder or teats should be washed and dressed with carbolized vaseline.
Lumps in teats ..	Due to a clot of milk, or sometimes matter.	Soften with hot fomentation and work between fingers.
Leaky teats ..	..	Hard to cure. Dip in alum-water and paint with collodion.

—*Department of Agriculture, Dominion of Canada "Bulletin"* No. 177 of 1935.

The Mineral Requirements of Milk Production: The Annual Cycle of Mineral and Nitrogen Metabolism of the Milch Cow

(Review by **M. Krishna Sastri, B.A., I.D.D.,** *Live-stock Section*)

This is a technical *Bulletin* (No. 319), published by the School of Agriculture and Experiment Station, State College, Pennsylvania. The subject of investigation is the Mineral and Nitrogen Metabolism (the mineral needs of milk production in general) of the milch cow. It is an elaborate nutritional study involving considerable expense, labour and technique. The authors, with their immense practical research experiences of decades in Animal Nutrition and Dairy Practice, have spared no pains to solve the complex problems in the determination of the mineral requirements of the milch cow. The unit of life of the milch cow significantly chosen is the cyclic variation of a complete lactation and gestation period. The discussion of the results and the conclusions drawn are of very great practical value to us in our studies on the nutrition of our own cattle in India.

The effect of the system of milk production on the general health of the cow and the consumer of her products is one of the important problems studied. The farmer-milk-producer or his farm has no mineral starvation unlike the town-milk-producer who subjects the cow and the consumer of her products to deficiency of nutrients—minerals and vitamins. The harmful condition of housing and inadequate feeding of milch cattle is very common in Indian cities with consequent defective city-milk-supply. Under the artificial conditions of stall-feeding in cities, with restricted natural grazing, the mineral requirements of the milch cow is of special importance to maintain her health and normal flow of milk rich in vitamins and minerals.

Since the intake of feeds by the cow in the early lactation period will be below the normal appetising level consistent with milk flow, the nutrients necessary for the elaboration of milk will be drafted from the body reserve of the cow. Hence, the loss of fat and minerals from the body as indicated by negative mineral balances. As lactation advances, there is improvement of balances, restoration of previous losses and also accumulation of new reserves of the elements for the next cycle of reproduction and lactation. The body storage of nutrients occurs more freely when the cow is dry than when she is producing milk; therefore, the length of the dry period and the care and treatment of the cow at this stage is very important in connection with the restoration of mineral balances in the future performance of the cow. It is significant to note that all the cows, which finished the experiment, made gain in Nitrogen and also in general live-weight to the extent of 2 per cent. to 6 per cent. of the intake; and the storage of Nitrogen to the extent of 3,558 grams each, indicates growth and re-alimentation of Nitrogenous tissues. This extensive storage is a conspicuous factor indicating the capacity of the milch cow to handle the various nutrients supplied, for her maintenance, lactation and reproduction.

Of all the minerals, Calcium and Phosphorus are of especial importance. The Calcium storage is increased as lactation advances and interesting account of Calcium metabolism is cited: under normal favourable conditions, cows maintain Calcium equilibrium and can store Calcium while giving considerable quantities of milk, provided roughages and grains are sufficiently fed, even without Calcium supplements. About 10 per cent. of the Calcium utilised (intake *minus* excreta) during the entire period of lactation and gestation is required for fœtal development or the formation of the calf.

The Phosphorus metabolism is not entirely independent of Calcium but there appears to be a functional exchange between the two elements in their metabolism. Phosphorus, which constitutes a large portion of

the animal body, both of skeleton and tissues, is of considerable importance. The utilisation of Calcium, Phosphorus and Nitrogen and their balances during the cyclic period of gestation and lactation is very significant.

The problem of mineral nutrients of livestock depends on the regional distribution of minerals in the soil, grains and fodders grown and also the special conditions of their use or necessity. Natural facilities for grazing, exercise and sunlight, abundant green feed and variety of forage is necessary for cows to maintain normal condition and health.

Roughage factor is very important for mineral assimilation. Conditions as to rations, environment, and freedom of movement, are essential factors conducive to assimilation of the vital essentials—minerals and vitamins.

Calcium metabolism of the milch cow is characterised by rapid loss from the body during the early stages of lactation and retention continues as lactation advances with most rapid storage at the end of the gestation period. The dry cow on dry feeds can store Calcium at a similar rate to that at which the fresh cow on dry feeds loses Calcium; conditions as to Calcium metabolism seems to determine, in a sense, the utilisation of other minerals. Since Calcium of the bones is most readily available for purposes of milk secretion, than the Calcium of the ration or mineral supplement, Calcium deficiency causes a nutritive depletion and functional derangement of the heavily-taxed milch cow and as such, careful feeding and long dry periods of rest to restore the losses, is essential. In cases of Calcium deficiency, excess storage of Phosphorus is indicated.

A positive Nitrogen balance probably favours Calcium retention, but there exists a prominent relationship between Nitrogen and other minerals in metabolism.

Bone-meal and ground limestone can be fed to cattle in quantities equivalent to 1 per cent. to 2 per cent. of the concentrated mixture. It is not necessary to be fed as a routine mineral supplement when there is no need. To ensure adequacy of Calcium or Phosphorus, bone-meal or ground limestone, four parts of the substance mixed with one part of common salt, should be accessible to the cows *ad libitum*.

Common salt is a necessary component of any ration fed and can be added to the extent of 1½ to 2 per cent. of the concentrated mixture.

It is needless to emphasise that the fundamental significance of the well-being of cattle is mainly from the agricultural practices of raising leguminous crops, rich in Calcium and Phosphorus and feeding them in abundance; this contributes the greatest nutritional equilibrium and then there remains no question as to the mineral deficiency of feeds or cattle decay.

The results of investigation on the whole suggest the desirability of building up extensive mineral reserves in young stock and growing heifers by liberal allowances of feeds rich in mineral nutrients. It is also important that the dry resting period of adequate length be permitted to restore early lactation losses by means of liberal and good feeding. It is, therefore, reckoned with a natural significant unit of time for the mineral and Nitrogen metabolism of the milch cow in the annual cycle of lactation and gestation. Keeping in mind these important aspects of mineral nutrients and their respective functions in the life of the annual cycle of the milch cow, the judicious breeders and stock-owners will recognise these principles of nutrition and mineral requirements of the milch cattle and endeavour to guard against the malnutrition and degeneration of their cattle by good treatment and care since cattle are the backbone of Agriculture and the cow is truly "the Mother of Prosperity".

Vegetative Propagation of Coffee

One of the first things noticed in any coffee plantation in Kenya is the extremely variable population. This is due to the heterogeneous nature of seedling material; even that from a "selfed" tree shows marked variations. There are two methods by which this variation could be overcome, by breeding and by vegetative propagation. The breeding of pure lines of coffee seed is very slow and entails many years' work covering several generations; it is, therefore, unsatisfactory. In consequence, some three years ago, our attention was drawn to the second method. At that time much success was being obtained with the reproduction by asexual means of other tropical crops, and it was considered that it might also be applied to *C. arabica*. It is here proposed to deal with the work which has been conducted to date.

Many possible methods of vegetative propagation have been under experiment, the results of which are dealt with under their separate headings. It should be noted that, owing to the marked polarity of coffee, all material used for cuttings or as scion wood for grafting is taken from vertical growth. Lateral wood produced only low-growing, flattened trees.

Cuttings.—It is of the greatest interest and importance to note how very closely results obtained here with coffee correspond to those obtained with cacao in Trinidad. With the exception of slight variations in technique, the raising of clonal material of these two crops appears to be closely related and thus any further work conducted in Trinidad should be followed by those working with coffee.

Whilst the grafting of coffee has been practised in some countries, notably Java, for many years, it is remarkable that so little work has been conducted on the propagation of coffee by cuttings. This may be due to the belief that cuttings do not produce good root-systems, or that they do not have the traditional tap-root of the seedling. That the seedling seldom produces a true tap-root but relies on a number of deep-rooting verticals is now proved, so no importance can be attached to this theory. The former suggestion is a possibility which cannot be overlooked and merits further investigation. The results of the experiments so far, nevertheless indicate that the root system of a 'cutting' compares very favourably with that of a seedling tree and that trees, 2 to 3 years' old, raised from cuttings, are comparable with seedling trees of the same age.

(*a*) *Hardwood.*—At the Scott Agricultural Laboratories, Nairobi, where most of the early work has been carried out, many hundreds of different types of hardwood cuttings have been planted out in open nurseries without success. In another district in Kenya, with very different climatic conditions—heavier rainfall being possibly the chief factor—a coffee planter has been highly successful with this type of cutting, the material used being prunings from trees grown on the Multiple-Stem system. Each cutting was approximately 2 feet long and about 1 to 1½ inches in diameter. How these cuttings will behave when they become mature trees must await further investigation, but it is interesting to note that they are already producing a prolific root-system.

(*b*) *Softwood.*—The propagation of this type of cutting entails the use of a closed frame or propagator. Several different propagators have been tested. That which is most suitable to local conditions consists of frames artificially heated by ordinary 'hurricane' lamps in chambers beneath and with a canopy overhead. Sand, thoroughly washed and steam-sterilized, is used as the rooting medium.

The type of cutting is of the utmost importance. That which has given the greatest success, although termed softwood, really consists of a tip, having semi-hardwood at the base and allowed to retain its young tip leaves. The cuttings used are 6 to 9 inches long and more than ¼ inch in diameter. Very suitable material will often be found growing as a bunch of suckers on a stumped tree, generally in the centre under dense shade. Attempts are now being made to induce this type of growth on a larger scale by various methods—shading, etc. Since the tip leaves must be retained, a high humidity must be maintained in the propagator and thus the frames are opened up for a few minutes only each morning. The rooting-medium, which is kept at a temperature between 68° and 72°F., requires watering about twice a week; on the other mornings, the leaves of the cuttings are subjected to a fine spray

of water in order to keep them fresh. Rooting may be expected in 3 to 4 months. Attempts have been made to stimulate the initiation of root-growth by treating the cuttings with certain gases prior to placing them in the propagators, but so far no success has been recorded.

(c) *Root and Leaf Cuttings.*—All attempts to propagate these types of cuttings have failed.

(d) *A Modified Form of Layering.*—Both correct layering and marcotting gave success during the first experiments conducted, but owing to the tedious nature of the work, and the slow rate at which it would be possible to raise large clonal populations, other methods were sought. Early work proved that if suckers, growing from an old stumped tree, were ring-barked near the parent stump and then etiolated, they would root with comparative ease, provided suitable weather conditions prevailed. This indicated that if some method could be found whereby the parent material could be made to produce a larger area for the production of sucker-growth, little difficulty would be experienced in raising large clonal populations. Thus, a technique has been evolved and whilst, owing to drought conditions, only early observations can be recorded, it is satisfactory to note that these are most hopeful. The following is the method adopted. A rooted cutting from a selected tree is planted out in a nursery at an angle of approximately 25 degrees from the horizontal. By keeping it pegged down, it will continue to grow in this plane. As this plant grows, suckers come away from the axillary buds. When about 12 inches high, they are ring-barked at the base and soil banked round them. When rooted, the soil is removed and the sucker cut away from the parent plant, which again will produce further cycles of suckers, for similar treatment. In the first cycle, only a few of the rooted suckers should be removed, the remainder being pegged over at right angles to the original plant to provide a larger area for the production of rooting-material in the second and subsequent cycles. Experimentation has shown that earthing up must not be carried out until the suckers are ready for rooting, and even then it is necessary to ring-bark each sucker.

Budding.—When the study of the vegetative propagation of coffee was started, considerable attention was given to the possibilities of budding, but as it has been found that the technique presents several difficulties, the method has been abandoned in favour of grafting. It is of interest to note that in referring to budding, Marshall says: "The union of stock and scion is much weaker than when grafting is used. In heavy wind, the entire growth is liable to break back to where the original bud was inserted."

Grafting.—Grafting has been widely used in Java where, due to the self-sterility of *robusta* coffee, decreased yields have always been

recorded from monoclonal plantations. This difficulty is now being overcome by the interplanting of different clones or by the introduction of a number of seedling trees. Fortunately, *arabica* coffee, being a self-fertilized plant, will not present the same problem. Considerable success has already been achieved with different methods of grafting in Kenya.

Grafting by Inarching.—Methods of inarching young seedlings in the nursery and of inarching one-year-old plants upon old stumped trees in the field were first attempted with considerable success by Rogers, Superintendent of Plantations, at Amani. His methods have been successfully adopted here and it would appear that either system is an easy way of grafting one variety of coffee upon another (*arabica* on *robusta*). Unfortunately, with this method, both scion and stock must be seedling material, an arrangement by which little ultimate gain can be obtained.

Cleft-grafting.—Most attention has been paid to this form of grafting, as by this method it is possible to graft clonal scion-material upon seedling stocks. Large numbers of grafts have been made in establishing a technique which gives a high percentage of successful unions. From observations made in the progress of this work, the following conclusions have been made regarding the technique:—

(*a*) The larger the stock and scion the easier it is to make a successful graft. Seedling stocks about 18 to 24 months old are much easier to graft upon than younger material.

(*b*) The stock should be cut just above or across a node and a cleft about 2 inches deep made between the buds.

(*c*) The scion is cut in the form of a wedge beginning on either side of a bud.

(*d*) The scion wood must be active at the time of grafting.

(*e*) The protection, which must be applied to prevent movement between the stock and scion and until union has been made, should vary according to the time of the year at which the graft is made. It has been found that the best time of the year for grafting at the Scott Agricultural Laboratories is during the cool, dry weather (June–October). In June, when sap flows freely from the stock, it will be advisable to bind the graft with gunny string only. Later in the season, at a time when there is little sap flowing and the weather is warmer, all cut surfaces, including the tip of the scion, should be protected with grafting wax.

(*f*) In all cases, the whole graft should be protected for a period of about three weeks by covering it with a loose waxed-paper cover.

Grafting in the Field upon Old Stocks.—All attempts at rind-grafting upon old stocks proved unsuccessful, so that other ways had to be

exploited. The method adopted, which is proving successful is that of grafting on sucker-growth encouraged from the base of the tree. When the sucker has obtained sufficient size and maturity, it is treated in precisely the same manner as are seedling stocks in the nursery. The ordinary cleft-graft is made as described above and is waxed and covered with a paper cover as before. The tree may be stumped back to the sucker either before grafting or afterwards. If it is left until after grafting, the natural shade thus formed will assist the newly-made graft in its early days. Care must nevertheless be taken to stump before the graft makes too much growth or it will be drawn up and tend to become whippy. The growth of a graft on an old-established root-stock is remarkably rapid.

Sufficient work has been carried out to show that coffee can be reproduced successfully by asexual means in Kenya. It would not be wise, however, to recommend it for field practice before further experiments have been conducted to study the many problems involved in mass production.

Among those which have already been forced to receive attention is the relationship between stock and scion and the effect of root-stocks of other *Coffea* species upon *C. arabica*. The behaviour of mature trees produced vegetatively deserves close attention and must be compared with trees raised from seed, both as regards variations in habit and in yield.

—*The Malayan Agricultural Journal*, Vol. XXIII, No. 10.

A Farm Management Study of Small Farms in Three Areas of Puerto Rico

The first project undertaken by the recently created Division of Agricultural Economics of the Experiment Station of the University of Puerto Rico was one dealing with small farms problems. The relative importance of small farms in Puerto Rico is shown by the census. In 1930, out of a total of 52,965 farms, there were 71 per cent. less than 20 acres in size. In addition, there are a number of farms above 20 acres in area that on account of rugged topography and poor soils could still be classed as small farms. Besides their numerical predominance, small farms are important from a social point of view. Under conditions of dense population the policy of any country regarding the size of farm and land tenure must be largely determined by the most efficient exploitation of the limited land resources compatible with the welfare of the greatest number. That serious consideration had been given previously to small farms is indicated by the fact that the Homestead Commission has already set 1,668 small homestead farms, of which 1,476 have already

been assigned. At the present writing various rehabilitation programs for Puerto Rico consider increasing the number of small farms.

The homestead farms in Vega Baja and in San Lorenzo were established by the Homestead Commission of Puerto Rico. This was a governmental board for the purpose of establishing urban workingmen settlements and small farms for agricultural labourers, which was abolished in May 15, 1933. It was composed of the Commissioners of Labor, Health, Interior, of Agriculture and Commerce, a permanent Commissioner and Secretary, and three other members.

The Commission met for the first time in 1919. The homestead farms in Vega Baja were assigned in 1921 and in San Lorenzo in 1924. The farmers agreed to pay for their farms in a definite period of either 10 or 20 years in quarterly instalments. The homestead project in Vega Baja covers an area of 261 *cuerdas* divided into 93 farms, 72 of which have been paid in full and titles have been given to the farmers. The San Lorenzo Homestead Area covers 2,191 *cuerdas* divided into 115 farms. At the present time, only two farms are up-to-date in their payments.

The Act of May 15, 1933 (Joint Resolution No. 47) created the Homestead Division of the Department of Labor which has taken over all work and properties of the abolished Homestead Commission.

The principal aim of this study was to obtain information concerning the status of small farms on the island. From July 1, 1934, to June 30, 1935, three areas were covered. It is planned for the following year to increase the number of areas studied in order that representative sections from other communities might be included.

Method of Procedure

The survey method was used in this study. A prepared farm management form was mimeographed and carried by enumerators who visited the farmers asking questions and recording answers.

The reliability of work of this nature largely depends on the training of the enumerator, on the freedom from bias of the farmer, and on obtaining a sufficient number of records. In all the sections included in the study, the results were considered satisfactory regarding these three items.

Explanation of Terms

Cuerdas operated, or total *cuerdas* per farm, is the number of *cuerdas* owned or rented which are operated as one unit, that is, by one man, partnership, company or family. Land rented to others is deducted from the total *cuerdas* per farm. A *cuerda* is .9712 of one acre.

Capital is the value of all farm property, including buildings, land, live-stock, equipment and supplies. It does not include house furniture or other household equipment. Unless otherwise stated, capital refers to the average value of inventory at the beginning and at the end of the year.

Gross Receipts include the total of the following items: (*a*) the amount received for all crops sold. (*b*) The amount received for live-stock sold. (*c*) The amount received for live-stock products sold. (*d*) The amount received from miscellaneous sources such as outside work and rent of buildings. (*e*) If the inventory value at the end of the year exceeded that at the beginning, this increase in inventory was also considered as a receipt.

Total Expenses include all farm business expenses: (*a*) General cash expenses. The expenses for new buildings and new equipment were included. In some cases these expenses caused an increase in the value of real estate and equipment at the end of the year. (*b*) Unpaid labor. In order to put all farms on a comparable basis, the value of the unpaid labor, except that of the operator himself, was included as an expense at what it would have cost to hire the work done. Household or personal expenses were not included, but the value of the board furnished to hired help was included. (*c*) Live-stock purchased. (*d*) Any decrease in inventory was considered as an expense.

Farm Income is the difference between gross receipts and total expenses. It is what the operator received for his year's work and for the use of the capital that was invested in the farm business.

Labor Income is obtained from the farm income by subtracting interest on the average capital invested. In these computations, 8 per cent. was used for the annual value of capital invested. This interest rate was decided upon after consideration of local conditions. Labor income, having eliminated the contribution made by capital, is comparable to the cash wages of a married man who is given a house to live in and various farm products besides. Labor income is accepted in the United States as the best measure of financial success in comparing one farm with another. This measure was used in this study. It is not comparable to salaries in the city. As used here, labor income means the sum that the farmer received for his year's work in addition to the use of a dwelling and products from the farm, after having allowed interest on the average capital invested, and having paid all farm expenses. Unpaid family labor was considered as a farm expense.

Labor Income from Farm Operations is obtained by subtracting the value of work off the farm from labour income. In order to be able to compare the returns of farm operations on the different farms,

excluding the influence of work off the farm, this factor was deducted from Labor Income.

Man Equivalent is the average number of men working on a farm for a year. It is obtained by dividing by 12 the total number of months that the operator, hired and unpaid labourers worked. The time of women and children is reduced to its equivalent in man time.

Number of Live-stock is the average number of animals for the year. It may not be the average of the number on hand at the beginning and end of the year, because a farmer may have had extra animals for a few months during the year, or he may have sold a large number just previous to the end of the year. In such cases, it was assumed that an estimate could be made which would more nearly represent the average.

Crop Index is a percentage comparison of the crop yields on one farm with the average yields of the entire group. The average yield per *cuerda* for each crop on all farms growing same was considered as 100. The yields of each crop on the individual farms were compared with this average and expressed as a percentage of same, then these percentages were totaled and a crop index for the total of all crops for each individual farm computed.

Animal Unit is a general method of comparing live-stock. It is based on the amount of feed consumed and the amount of manure produced. One cow, bull, steer, ox, or horse, is counted as an animal unit and other animals are compared to these. Young stock usually are counted as equal to one-half of a mature animal. Seven sheep, 14 lambs, 5 hogs, 10 pigs, 2 heifers, 2 colts, and 100 hens are each counted as an animal unit.

Farm Privileges consist of all the contributions of the farm towards the family living. This includes such terms as crops, live-stock, live-stock products, and fuel consumed in the home *plus* estimated rental value of farm dwellings.

Labor Earnings is obtained by adding farm privileges to labor income. This figure is more nearly comparable to the income of a married man working in town.

Return on Capital is obtained by taking farm income less value of operator's labor. The value of operator's labor is estimated by the farmer, and it is his estimate of the value of his own labor and management on the farm business.

Summary and Conclusions

According to the 1930 Census, 71 per cent. of all farms in Puerto Rico were less than 20 acres in size.

Small farms in three selected areas were studied for the crop year July 1, 1933 to June 30, 1934. 63 homestead farms and 88 independent farms were studied in the Municipality of Vega Baja and 45 farms in Barrio Espino, San Lorenzo.

The Municipality of Vega Baja lies on the northern coast of the Island; topography is flat and rolling; average annual precipitation is 67.89 inches. The Municipality of San Lorenzo lies in the southeastern part of the Island, topography hilly, and precipitation 81.80 inches.

Average size of Homestead Farms, Vega Baja, was 3.02 *cuerdas*; Independent Farms, Vega Baja, 17.19; and the Homestead Farms, San Lorenzo, 14.18.

Total capital invested per farm was $340 for the Homestead Farms, Vega Baja; $1,068 for the Independent Farms, Vega Baja; and $184 for the Homestead Farms, San Lorenzo.

On the Homestead Farms, Vega Baja, 52 per cent. of the crop area was devoted to sugarcane and 93.5 per cent. of the crop receipts came from this source.

Tobacco and sugarcane were the most important crops on the 88 Independent Farms covering 38 per cent. of the crop area and accounting for 76.6 per cent. of the total receipts.

Tobacco was the most important cash crop in Homestead Farms, San Lorenzo. 19 per cent. of the crop area was devoted to same and accounted for 86.4 per cent. of the total receipts.

Live-stock was relatively insignificant in all areas, accounting for about 8 per cent. of the capital invested and 6 per cent. of the total receipts.

Miscellaneous receipts were important and amounted from 35 to 39 per cent. of total income. Labor off farm amounted to 39 per cent. of gross receipts of the Homestead Farms, Vega Baja; 23 per cent. of the Independent Farms, and 13 per cent. for San Lorenzo Farms.

Gross receipts for Homestead Farms, Vega Baja, were $202; for the Independent Farms, $331; and for the Homestead, San Lorenzo, $142. Expenses were $127, $228, and $113, respectively.

Labor income for the Homestead Farms, Vega Baja, amounted to $48 and cash available for family living $117. For the Independent Farms, the labor income was $20, while the cash income available for family living was $171, and for the San Lorenzo Farms, the labor income was $15 and cash available for family living $52.

Cash income *plus* farm privileges amounted to $240 for the Homestead Farms, Vega Baja; $342 for the Independent Farms; and $133 for the Homestead Area, San Lorenzo.

Generally, as net *cuerdas* in crops increase, labor income correspondingly increased.

All groups having gross receipts less than $100 per farm showed *minus* labor incomes.

One of the most marked relationship existed between gross receipts per *cuerda* and labor income, showing the necessity of the intensive use of land on the small farms.

The groups in all—three areas where the farmer handled the largest number of *cuerdas* of crops per man, made the highest labor incomes.

Good yields were found to be essential to profit on small farms.

Age was a rather important factor in determining the business success of a farmer. The older aged groups in all cases showed the lowest labor incomes.

There is an opportunity for small farmers to improve their standard of living by placing more emphasis on the production of crops and live-stock products for family consumption.

Many of these small farms did not provide sufficient work and income for a decent standard of living and the farmers were compelled to supplement their earnings by doing man labor off the farm.

The financial success of small farms is determined not by one but by many factors. A sufficiently large area of good land, intensively tilled to obtain good crop yields, farmed by a young vigorous operator, with one or more good cash crops, having ready access to markets are among the essentials for successful financial operation of a farm.
—*University of Puerto Rico, Agricultural Experiment Station, "Bulletin"* No. 40 of 1935.

Memorandum on Coffee Research and Experimentation

BY

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Field experimentation has made great advances during the last ten years. With the first appearance of Fisher's book, *Statistical Methods for Research Workers,* in 1925, his methods have been increasingly applied, more quickly in annuals as being simpler.

The method embraces three principles which are essential to the modern design of experiments:—

(1) Replication, which increases the precision of the experiment, and provides an estimate of error.

(2) Randomization, which enables comparisons to be made of different treatments on different plots.

(3) Localisation of control, which eliminates soil differences in the field, and, by the analysis of variance, removes them from the estimate of error.

With perennials there are great initial difficulties, such as:—

(1) The length of life of the plant;

(2) The variability in the characters of the seedling material which is often the only type available.

Even in temperate zones it is recognised that the old type of experiment is valueless.

In *Technical Communication*, No. 2, of the Imperial Bureau of Fruit Production,* to whom acknowledgment is made, it is stated as follows:—

"These earlier workers, however, soon found that experiments with fruit trees 'exhibit errors from sources which do not generally affect experiments in agriculture', and it soon became apparent that both the material which they used and their methods of experimentation would need great improvement if such experiments were to be of any practical value. Thus Chandler, one of the foremost of American workers, emphasises the fact that such field experiments 'have not yielded as valuable results as was expected of them'. This he attributes to the high variation, and notes that 'experimental results have been published in which the yield of the treated plots was nearly twice that of the untreated plots and yet it was not certain that the difference was due to the treatment'.

Workers at the Geneva and Pennsylvania Stations also deplore the meagreness of the results of a period covering some 30 years of fertilizer experiments.

Why have these early trials failed to yield information and what are the causes of the larger errors to which they were subjected?

Field experiments are subject to error from two main sources: (i) the inherent variation in the material which is being dealt with, and (ii) the variation which is due to outside factors reacting on the plant after the experiment has been planted up."

The following is a further extract from the above publication, and sets out clearly the difficulties in the way of field experimentation from an authoritative source:—

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* *Field Experiments in Horticulture*, by T. N. Hoblyn, Dip. Hort. (Statistician, East Malling Research Station, Kent), 1931.

"Field Experiment with Permanent Crops in Tropical and Sub-Tropical Countries:

Whatever opinions they may hold as to the merits of Fisher's methods for application in the tropics, research workers there are admittedly confronted with difficulties peculiar to their situation and to the crops with which they have to deal. These difficulties will now be briefly considered . . . .

(*a*) In this sub-group (*i.e.*, crops which are cross-fertilized and heterozygous, and which are capable of being reproduced by vegetative means) are found such important crops as cacao, citrus fruits, rubber and cinchona, which can all be propagated by budding or grafting, and tea, dates, bananas, pineapples, and tapioca, which are usually propagated from cuttings, slips or suckers, rubbers, cinchona, tea and tapioca are included as being subject to much the same rules of experimentation as trees cultivated for their fruit.

In this class, by far the most important problems at present are those which concern the standardisation of the material with which experiments are to be carried out. Cheesman says of ordinary plantation cacao, exhibiting a range of variability, probably at least as wide as that covering all the existing horticultural varieties of apples.

These remarks apply equally to the vast majority of crops in this class, as grown to-day. Citrus fruits, indeed, have advanced one step further and definite varieties are known and propagated by budding on to seedling rootstocks; but as long as this unknown factor of the seedling stock is allowed to remain, with the possible exception of the West Indian lime, which is said to breed true from seed, even this large class of fruit trees will not be a really satisfactory crop for field experiment.

An interesting possibility in connection with citrus fruits is the utilization of the phenomenon of polyembryony—a common occurrence in this class of fruit trees. By this means, it may be possible to raise vegetative families from seed, as long as the sexual embryos can be recognized soon after germination and removed. These possibilities are already being explored.

The process of standardization has also already begun with cacao and rubber, and clonal varieties are being established and propagated by budding. That the standardization of the scion varieties is only the first step on a long journey has, however, already been shown by Harland who, referring to cacao, says: 'There is no method of telling whether a tree will transmit heavy yield either to its budded or seedling offspring except by testing it.' The next step is once more the elimination of the seedling stock, and research work having this end in view has already been started. . . . .

(*b*) The standardization of such material must necessarily be a much longer and more uncertain process than where vegetative propagation is possible. Already breeding work and selection of seed from heavy bearing parents have been started, but it will be a long time before really uniform trees are a practical possibility.

In addition to variable material, tropical workers have to face many difficulties which are not usually met with in temperate countries. These include aspect, gradient, the necessity for shade trees, artificial means which have to be adopted to check erosion, such as silt pits, contour drains, terraces and contour hedge crops. Again, the necessity for following the contours on steep lands to prevent erosion increases the difficulties of spacing and plot arrangement.

Experimentation with Variable Material.

In the meantime, until these various processes of standardization are accomplished, and in the face of these difficulties, are field experiments with such variable material worth while?

The answer to this question is most definitely, "yes"—provided the experimenter is prepared to take enormous trouble to get his results and refuses to be hurried. But if such conditions cannot be fulfilled, then, in the writer's opinion, the experimenter would be better advised to postpone the elucidation of such questions as pruning, manuring, and cultivation, and concentrate on the task of standardization.

The importance of individual tree records with deciduous crops has already been stressed. With such variable tropical crops as are now under consideration it is the only possible way to get reliable results. In such experiments every tree is a separate entity, and such a quality as a heavy or light bearing capacity is only one of the many ways in which it may differ from its neighbour. The only way, therefore, in which a general answer can be obtained to such a question as the effect of a particular fertilizer upon cacao is by observing the effect of that manure upon a large number of individuals and comparing their performance with that of an equally large number of individuals from which that fertilizer has been withheld.

This information can be obtained with greater accuracy and with fewer trees in some cases, if the performance of the trees is known for some years before the differential treatments are begun. On the River Estate, Trinidad, large numbers of cacao trees have been recorded for a ten-year period, and it has been definitely shown that heavy bearing trees as a rule remain heavy bearers and light bearing trees remain poor croppers.

This fact is said to be true for several other crops, including cocoanuts and oil palms, but a word of warning would seem to be necessary here.

Such a record, if it is to be of any value, must be kept for a sufficient number of years, and the bearing capacity of young trees should not be taken as a criterion of their future performance, *e.g.*, cocoanuts cannot be considered mature until five years after the plantation has come into full bearing.

Basing his deductions on the yields of cacao recorded on the River Estate, Freeman considers two years' record the minimum period, provided the cropping is undisturbed, but other workers have, in conversation with the writer, suggested a considerably longer period than this.

With regard to cocoanuts, it must be remembered that most plantations are uncultivated, and the mere fact of bringing a plantation into cultivation for the purpose of a manurial trial will have a considerable effect on the trees. This crop then should be cultivated and recorded for at least five years before the manures are applied. With apple trees, it is a characteristic of certain combinations of scion and rootstock that they start to bear heavily early in life, while others do not readily reach their full bearing capacity until more than ten years old. There seems every possibility that the same phenomenon may be apparent in the heterogeneous collections of seedlings or clonal varieties on seedling stocks at present under consideration. Thus, in the case of the oil palms previously referred to, though the correlation between successive years' yield in the 5th, 6th and 7th years was always positive, it was not until the eighth season that the yield was very highly correlated with that of the previous year.

The problem of arranging such experiments is rather complicated. If the variation is not very high except in yield, ordinary randomized blocks may be used, and the data analysed, not on the basis of actual yield, but taking as the variable the rate of increase over the previous record of the tree. Lord and Abeyesundera have used what they term the 'Percentage Increase' method for plots of rubber trees (calculating the percentage increase of each plot over the previous year's yield), and have obtained thereby seemingly very accurate results.

They recommend the use of 24 tree plots replicated in randomized blocks, laying down quite rightly that this percentage increase method is of no use without replication. The writer, however, will go further in saying that with seedling trees, even though, as in this case, they may have one parent in common, the method may prove definitely misleading unless the variation of individuals is taken into account.

The high variation in young rubber trees at the Rubber Research Institute of Malaya, shown by Haines, further enforces this argument.

This worker has laid out a large-scale manuring experiment on rubber trees, using the latin square method of arrangement, and plots of 81 trees surrounded by a guard row.

In a recent paper, he suggests that 'plots should be adjusted to the natural unit for estate recording,' but for trials other than manurial trials individual tree records are recommended.

The use of randomized blocks for individual tree plots is apt to entail difficulties, as will be shown in the third example in this paper, for, though such a method may be suitable for such management experiments as pruning, for manurial, shading, spacing or cultivation trials larger plots are necessary.

It seems, therefore, that the only possible way to get satisfactory results is to use comparatively large plots such as these workers suggest, and to consider not only the variation between plots but also that within plots by taking individual tree records.

Another difficulty which may make the ordinary use of randomized blocks or the latin square of little value is the nature of the soil heterogeneity. Martin and Beckett, in a recent paper, say of West African conditions: 'In our experiments, we are not concerned with major soil differences such as those due to different soil formations, but to minor differences due to causes such as previous cultivations, positions of ant-hills, dung-heaps and minor differences of level and drainage.'

In Ceylon again, experimental work has to be done on ground of all levels which has been cultivated in very small holdings for generations.

For such cases, Martin and Beckett have suggested a modification of the randomized block method, when treating trees of known history, by which the blocks are allotted, not to different positions of the ground, but to differences in yield capacity. Thus, the trees are grouped in categories according to their previous yields, and a block containing each treatment at random is allotted to each category. This method involves, of course, individual tree plots.

The necessity for guard rows is mentioned in other parts of this paper. With tropical crops these are no less essential, and if possible some tree of uniform size and root range should be used. This applies especially to experiments involving such crops as cocoanuts and rubber, where the root range is very great. Sampson has shown that where manure was applied to a strip of 8 feet down the centre of the middle of five rows of cocoanut palms, while the row which received the manure gave the largest increase in yield, both those immediately adjoining it gave a very appreciable increase also.

The possibility of utilizing shade trees in the guard rows, especially where shade is not the immediate object of the trial, is worth consideration.

Finally, it must be repeated that a field experiment with a heterogeneous crop is a complicated and precarious business, calling for the

utmost care and patience. There are, however, definite signs that standardization of material, with many of the major tropical and sub-tropical crops, will, in time, become an accomplished fact. The growing appreciation that it is the most vital necessity for the improvement of these crops gives definite hope for the future."

To summarize, it is recognized now almost universally that certain data must be accumulated regarding tropical perennials before precise field experiments can be successfully carried out.

That planters see this is shown by the fact that such investigations have been carried out mainly at crop stations supported almost entirely by the planters themselves, such as the Rubber and Cocoanut Research Stations of Ceylon and Malaya.

The most important data required are:—

(1) Individual tree records;

(2) Uniformity trials;

(3) Knowledge of plot size; and, for precise work, standardized material.

Up to 1934, little had been done in the study of these factors in *C. arabica*. Even at this time many planters in East Africa are unaware of the lines of successful progress in other crops, and fail to realize the vital necessity for such work on coffee.

Fortunately, however, with the inception of the Coffee Research and Experiment Station, Lyamungo, Tanganyika Territory, this need was recognized and was made a fundamental basis on which to build up an experimental programme.

At this date the Station is in possession of individual tree records of some 10,000 of individual trees, in blocks of 700–800 for a period of two years. The recording continues.

The figures show that the variability in yield and growth is as great as that for any tropical perennials yet recorded and, moreover, is accompanied by very pronounced biennial bearing.

The data are sufficient to justify field experiments on certain of the more uniform blocks, provided each experiment is repeated in several localities and over several seasons.

Knowledge as to plot size has also been obtained.

For precise work considerable advances in the standardization of planting material have been made. Such material will be available in considerable quantity in 1937.

—*The East African Agricultural Journal*, Vol. II, No. 1.

Pineapple in Malaya

(Extract from an Article on Malayan Fruits)

The Malayan pineapple canning industry was founded about 1888, when factories were opened by Europeans in Singapore. Within two or three years, ownership appears to have been transferred to the Chinese and there were at that time several small canning factories in Singapore and Penang. The latter port, as a centre of cultivation and canning of pineapples, was never of great importance, but in Singapore, the industry became well established and later extended to the State of Johore. The importance of Johore in this respect has been largely due to the development of that State for rubber cultivation with which pineapples are grown as a catch crop, and to the fact that the area of land in Singapore available and suited to cultivation of pineapples is limited and has decreased.

The bulk of the crop is used for canning purposes. The extent of production may be seen by an examination of the official returns of exports from Malaya. The annual exports stood at an average of about 20,000 tons from 1904 till 1916. A rapid decline in the trade followed for the next three years. Thereafter, owing largely to the very considerable extension of rubber planting which took place in southern Johore, there followed a corresponding increase of the planting of pineapples as a catch crop. Consequently, exports, which occurred in 1926 and 1927, coincided with the activities of canners who formed a combine to fix prices. The lower exports in 1933 were definitely the result of disagreement between growers and canners as a result of which many of the former destroyed part of their crop in an attempt to raise fresh fruit prices.

In addition to the cultivation of pineapples for the very important canning trade, areas exist in many parts of the country for the production of the fruit for dessert purposes. The total area planted for this purpose probably amounts to about 2,000 acres, the produce of which is consumed locally.

Varieties

The variety most commonly grown for canning is a type of pineapple which is very similar to the "Red Jamaican" or "Spanish Pine" of the West Indies. The fruit is small, weighing from 3 to 5 lbs., and has an excellent flavour when canned. The "Mauritius", and the "Smooth Cayenne", or "Kew Pine" are chiefly grown for dessert purposes. A number of other varieties is under cultivation on an experimental scale at the Central Experiment Station at Serdang in Selangor and at the Pineapple Experiment Station, Singapur, where experiments are also being conducted on selection and breeding of pineapples with

the object of improving the quality and reducing the depth of "eyes", as deep "eyes", in the fruit result in considerable waste in cutting for canning purposes.

System of Production

Many of the owners of pineapple canning factories own land upon which they have planted pineapples. In some cases the owner undertakes the entire responsibility of planting and bringing the area into production. On the other hand, many areas are worked on a system whereby the Chinese owner arranges with a number of Chinese squatters to plant up his land with pineapples and to keep it clean for an agreed charge per acre per month. Each squatter is thus definitely and absolutely responsible for a portion of the estate and generally erects his temporary abode thereon. The agreement usually provides that the squatter shall get 50 per cent. of the value of the pineapples as a bonus after cartage costs have been deducted, and the agreement, as a rule, contains a clause which provides for the payment to the squatter of a sum of money per acre for clearing the pineapple plants from the land after five years.

Climate

The well-distributed and heavy rainfall of Malaya renders this country particularly suitable for pineapple cultivation. The equatorial conditions are responsible for the fact that two main crops are harvested annually instead of one big crop and one small crop as occurs in latitudes further from the equator. Even in Malaya, however, the January crop is decidedly smaller than the June crop.

Soils

Pineapples grow on a wide range of soils, but favour the medium type of soil aeration and drainage. For this reason also, gently sloping lands are to be preferred. These conditions are met with on the majority of the inland areas, wherever topography lends itself to free natural drainage. In particular, the quartzite soils, and the granite soils are known to be suitable. Pineapples are also grown in Malaya on peat soils. In some cases, pineapples have been cultivated by Europeans on newly opened peaty land destined for rubber, less with the idea of profit from the fruit than for the favourable effect pineapple plants are said to have in improving the conditions of such soils.

Until recently, it has been the custom to cultivate pineapple in Malaya either on newly-opened jungle land, on land which has been out of cultivation for a number of years, during which period it has reverted to secondary jungle conditions, or as a catch crop with rubber.

Planting Material

Pineapple planting material is of four descriptions, *viz.*, ratoons which are formed from buds on the stem among the roots; suckers formed in the leaf axils; slips formed from buds appearing immediately below the fruit; and crown slips and crowns, formed from buds beneath and around the crown of the fruit. Ratoons and suckers are very suitable for planting purposes, as they produce fruit earlier than do the less strongly-developed slips, but slips (suckers) from buds below the fruit are used almost universally as planting material in Malaya, owing to the fact that these slips are produced in larger numbers, are uniform in size and age, and cost less to transport.

A recently introduced method of propagation originated in Trinidad has, for its object, the production within a short time of a large number of uniform plants of a variety. In this method, cross-sections 1/5th inch in thickness are cut from the mature aerial stem and rhizome, which has been stripped of its leaves, roots and scales. The sections are placed in a 5 per cent. solution of potassium permanganate for five minutes, the solution drained off and the sections air-dried for two days. The sections are then planted horizontally in boxes and kept in the shade. The dormant buds commence to grow a month after planting and may be transplanted to beds when two months old. When sufficiently developed, the plants are separated and planted in the field.

This method has been tried experimentally in Malaya, but it is too early to state to what extent it is adaptable under estate conditions, though, for the multiplication of new or rare varieties, it possesses undoubted advantages.

Planting in the Field

In Malaya, single row planting is the usual method adopted and plants are usually spaced in the field 5 feet by 2½ feet, with a six-foot path at every 100 feet. This spacing gives from 3,000 to 3,400 plants per acre.

Suckers, slips, and ratoons for planting are cut square at the base, the lower leaves are removed, and the planting material dried in the sun for a while before being planted.

The plants are placed from three to four inches in the ground, the actual depth depending upon the size of the plant. Care is taken that no soil or sand enters the bud as it will kill the plant, or at least retard its development.

After planting, the fields are periodically weeded, but, apart from this operation, and the earthing up of the plants and removal of excess buds, no further cultivation is usually given in Malaya.

Yields

The first crop is harvested about 18 months after planting, from 1,200 to 1,500 fruits per acre being obtained. Thereafter, for a further 3½ to 4 years, two crops are reaped annually, *viz.*, in May, June and July, and in January, February and March, although a small amount of fruits are coming in all the year round. After the crop is in full bearing, the first four crops may give 4,000 to 5,000 fairly large fruits per acre, per annum, followed by three or more crops smaller in number and poorer in quality.

The economic life of the plant under Malayan conditions depends upon whether it is cultivated as a sole or as a catch crop, and even then is still open to doubt. Under sole-crop conditions, present opinion is veering to a system of more frequent re-planting, and application of artificial fertilizers at regular intervals.

The fruit for canning is either sold by the growers (if they are not also owners of factories) to the canneries at the factory door, or on the road-side, and is also purchased by the drivers of passing lorries at road-side for re-sale to the factories.

Catch Crop *versus* Sole Crop

Until very recently the pineapple canning industry has been maintained from supplies grown as a catch crop, generally in conjunction with rubber planting. This system was worked successfully by the Chinese for a number of years and proved most remunerative, especially at a time when the canned product commanded a much higher price than it does in the present depressed state of markets.

About the year 1930, it was realised that, if the market for Malayan pineapples, which had by then grown to some importance, was to be maintained or further developed, consideration must be given to the question of the production of the fruit as a more permanent crop. There was already an easing-off in the area of land newly planted with rubber and suitable land for development by this method was not inexhaustible. Furthermore, the Malayan Government closed their books against further alienation of land for rubber planting and the number of alternative crops to rubber as the main crop was very limited.

It was realised that the change of policy would entail departure from the somewhat haphazard customary method of cultivation. The new system would necessitate more cultivation, manuring and consideration of closer planting distances and of rotation of crops. These questions are being studied by the Department of Agriculture, in Singapore, Johore and Serdang and also by the growers. The introduction of rubber regulation, a feature of which is the prohibition of further

planting of rubber, has rendered the problem urgent. In 1934, one-third of the total area of pineapples in Malaya was planted as a sole crop.

Canning

Factory methods for canning pineapples differ considerably in Malaya from those employed in other countries. Whereas in modern packing methods, machinery is used as much as possible, in Malaya, hand-labour, owing to its relative cheapness, is usual for almost all the operations. The local canning pineapple is not suitable for mechanised peeling and slicing operations, unless control of size and type of fruit is established by packers. Under Malayan conditions, factories are at no great distance from the sources of supply of the fruit, thus reducing transport costs. The preparation of the fruit for packing is done by hand-labour, and the cans are made in the factory, each factory being equipped with the necessary machinery for this purpose. This latter fact contrasts with the system adopted in competing countries of production, where the cans are purchased from a central can-making factory.

The fact that by the Malayan method, transport of fruit and empty cans is reduced to a minimum, has its advantages. Factory-produced cans are dearer than those produced in the canneries by the Chinese employees. The fruit can be harvested in a riper condition than would otherwise be possible; factory methods are such that generous use can be made of labour, which is comparatively cheap; and freight, which is comparatively expensive, is reduced to a minimum. On the other hand, the packer has but little control over the quantity or quality of his fruit supplies which is a definite disadvantage.

The question of power must also be considered in connection with the situation and size of the factory and of the amount of machinery employed. The factory in this country is usually of a comparatively temporary nature and in many cases situated at a distance from a cheap or convenient source of electrical supply. The usual unit is such that the power can be supplied by an engine of 30 to 40 h.p. which is sufficient for a factory turning out from 1,000 to 1,500 cases per day.

The capacities of the Malayan factories vary considerably. During the season, the factory may work night and day, and it is on this basis that capacity is estimated. The largest factory can turn out about 3,000 cases of 48 tins per case per day; the average factory has a capacity of about 1,000 cases per day.

The operation of preparing the pineapples for canning needs little description. Canned pineapples are exported either as slices, cubes or crushed. Whole pines may be exported to fill a special order. Pineapple cores have recently been canned. The work is done by hand at long tiled tables, the operator wearing suitable clothing and a rubber glove,

performing the cutting operation with a knife something akin to a chopper. The waste of fruit due to peeling, coring and removal of the "eyes" is considerable; with "sliced" fruit it amounts to about 30 to 40 per cent., and with "cubes" the waste is between 60 and 70 per cent. of the fruit.

While cutting the fruit, the operator grades the product. Fully ripe fruit of good quality is put aside and is destined for export as "Golden"; the remainder, excluding very irregular pieces and very unripe fruit, is packed as the G.A.Q. (good average quality). The rejects from this grade are classed as No. 2 and are sold only on the Far Eastern market.

A considerable space in the factory is devoted to the manufacture of the cans. These are made from tin-plate which is imported in sheets for the purpose.

The sheet-tin is cut into strips in a shearing machine, the strips being of convenient size for further cutting of body blanks and strip for tops and bottoms. The bodies are made by passing through a body forming roll, and a flanger. The bodies are then put together and soldered by hand. The tops and bottoms are stamped out and affixed to the body in a machine known as a double seamer. The tin is filled with fruit and the top fixed with a seamer. No solder is used for fixing the tops and bottoms; a thin strip of rubber is placed round the lid, which when flanged hermetically seals the can.

The cans are filled with fruit and removed to syruping trays, where a syrup made from cane sugar is added until the cans are completely filled. They are then removed to the seaming machines and capped.

The amount of sugar used varies with the product and the market for which it is destined. The natural sugar content of Malayan pineapples as canned is usually taken to be 11 per cent.; though, if the fruit is fully ripe, it may be as high as 17 per cent. About 90 per cent. of the canned pineapples from Malaya are packed with the addition of cane sugar, giving a total sugar content of from 20 to 25 per cent.

The sealed cans of fruit are cooked for approximately 30 minutes at a temperature of 212°F., after which they are stored in a cooling chamber and packed for export, either labelled or without labels, depending upon the specification of the particular order.

Canned pineapples are packed in case of *serai* wood or of three-ply wood. The former is cheaper and it is stated that it is used for nearly 70 per cent. of Malayan exports.

The usual packing allows 1½ lbs. of fruit per can, forty-eight such cans being packed in a case. For a case of canned pineapples, about seventy-five fresh fruits are required.

By-Products

Only about one-third by weight of the pineapples received in the factory is utilised. The resultant large quantity of waste is frequently a source of embarrassment, especially if the factory is within a municipal area.

The economic disposal of waste has been investigated. It is found that, as a preliminary to its disposal, pressing and grinding are necessary. Incineration of the solid portion for the production of an ash possessing valuable manurial properties has been suggested, the liquid portion being used as a source of alcohol. Pineapple bran, used as food for cattle can be prepared and has already been marketed in Hawaii. A third method of disposal is to return the partially dried residue to the field and to spread it in shallow layers.

None of these methods has been employed to any extent in Malaya. In most cases the refuse is either placed in heaps or is dumped at sea. Control of the dumping of waste is, however, exercised by Public Health Authorities.

Marketing

Most of the canned pineapples are marketed through the European exporting firms in Singapore. Malaya is the second largest producer of canned pineapples, Hawaii taking the premier position. Malaya has captured a market for a cheap product. This was rendered possible by cheap cost of production and by low costs in the field and factory. For these reasons, it is possible for Malaya to market a product which, if not perfect as far as grade is concerned, is a canned fruit of good quality and flavour and the cheapest canned fruit in the market. For these reasons, it has become the poor man's dish and has found a ready market in the United Kingdom. Improvements in grading have more recently resulted in an extended market in other countries.

The distribution of exports from Malaya in 1933 was as follows:— United Kingdom 45,806 tons, valued at $4,746,949; Canada 6,241 tons, valued at $665,935; the continent of Europe 4,032 tons, valued at $380,674; other countries 3,502 tons, valued at $491,898. Thus, the total exports were 59,581 tons, valued at $6,285,456, of which the United Kingdom took 77 per cent. Over 80 per cent. of the canned pineapples consumed in the United Kingdom is the product of Malaya.

The export value of pineapples has varied considerably in recent years. Between 1904 and 1918, the average was $4.73 per case: in 1919, it averaged $12.84; and in 1920, $16.30; thereafter the export value dropped steadily.

Actual market prices per case in Singapore in the past two years for the recognised grades were as follows:—

	Cubes	*Sliced (flat tins)*	*Sliced (tall tins)*
	$	$	$
1932 ..	3.34	3.27	3.48
1933 ..	3.11	3.00	3.19

Improvement of the Industry

Acting on the recommendation of a Singapore Conference which reported to the Governments concerned early in the year 1931, efforts are being made to improve the Industry; in the field, by investigating the cultivation of the crop, and improving the varieties grown for canning purposes; in the factory, by closer control of the factory conditions, and by the introduction of a grading scheme. Legislation now provides for the registration of all factories, the marking of cans to provide a means of identifying the factory from which they originated and the enforcement of hygienic conditions in factories. It is hoped that, in the near future, agreement in the trade will be reached for the introduction of a scheme of grading and inspection.

The Malayan canned pineapple has gained for itself an enviable reputation on the world's market as a cheap and good canned fruit at a low price. Provided that supplies can be maintained and that the improvements made in quality do not result in material increase in cost of production, the market for the Malayan product should be considerably increased in the next few years.

—*The Malayan Agricultural Journal,* Vol. XXIII, No. 3.

Potato Growing in Victoria*

No. 7. Planting

BY

J. T. Ramsay, *Potato Expert*

The planting of the potato crop in Victoria extends over a considerable portion of the year. Commencing as early as June, in districts favoured with a mild climate, a succession of plantings continues without a break from June to December, and in the case of very late districts even into January. The major portion of the acreage, however, usually is planted during the period extending from the middle of October to the end of November.

That there is still a good deal of slackness or carelessness amongst potato-growers is rather surprising in view of the fact that the potato

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* The previous articles of this series have dealt with the conditions and selection of seed, seed storage methods, change of seed, plant food requirements, the use of artificial fertilizers and preparations for planting.

is one of the most expensive crops to produce. As a rule, the land is high-priced, and the cultural operations necessary for the maximum and complete development of the crop are such that they cannot be given without the expenditure of much time, labour and money. It is estimated that the average cost of production up to the point of digging is about £14 to £15 per acre. After that, costs for digging, bags and marketing are, of course, dependent on the weight of crop produced.

Since then, growing potatoes is a business involving an outlay of a large amount of capital, it is necessary that the planting of this crop should be carried out in such a manner as will give it every opportunity of a successful start. The necessity for thorough preparation has been stressed previously.

The actual planting, for the most part, is done by hand, though a fair percentage of the Victorian crop is seeded with mechanical planters. Both methods are efficient. With hand planting, it is advisable, first to run the harrows over the fallow to be sown so as to produce an even surface in order that the plow may work at a regular depth. It is not advisable to harrow more than a day or so ahead of planting, as, in the event of rain setting in, the soil, worked down finely by the harrows, is liable to become baked on the surface. The sets should be placed on the ploughed land side of the furrow, as there they are not only in loose soil, but also out of the way of the Horse's feet, when covering is being done, and less liable to injury from this source.

The single, double, or treble furrow plough may be used, the last, of course, being the one most commonly employed. An excellent combination, however, is a single and a double furrow plough working together. This outfit is really better than the treble furrow plough, one of the main reasons being that the furrow in which the potato sets are placed need not be opened until planting is actually ready to be done. This is important when weather conditions are dry and warm. If the planting furrow is left open for even the space of time of the lunch hour, on a warm day, the crop resulting there invariably is lighter than the adjoining rows.

Manuring

In practically all cases, some manure should be given to fortify the natural fertility of the soil. This question has been dealt with in a previous article.

Where manures are applied they should, in all cases, be placed in the furrow with the seed. Numerous tests have shown that placing the manure in close proximity to the seed sets produces a crop invariably heavier than when the fertilizer is broadcast prior to or after planting. Research work has shown that the potato plant takes up

plant food much more rapidly in the early stages of its growth than it does later. This fact emphasizes the advisability of having the manure close at hand to supply the needs of the crop immediately its root system commences to develop. If the fertilizer is broadcast and harrowed or ploughed in, a great percentage of it is distributed at such a distance from the sets that considerable root growth must be made before contact with the fertilizer is made. Consequently, rapid growth of the young plants is not possible, and the crop suffers a handicap which it can never subsequently overtake.

Depth of Planting

Another factor of importance to be considered is the depth at which the sets are placed in the soil. The potato is a sun plant, and the shallower it can be grown the better. It revels in a combination of sunlight and moisture. The habitat of the original wild potatoes from which all improved and commercially-grown varieties have evolved is in the tropical belt of South America. Under tropical conditions there is, of course, an abundance of summer rain. The fact that the potato is a moisture-loving plant, and remembering the actual natural environment to which it is indigenous, makes it easy to comprehend that the governing factor of the depth at which it should be planted is the shallowest depth at which it can be assured of the requisite moisture for its needs. Now, sub-tropical and temperate zones, in which the bulk of the world's potato crops are produced, are not subject to the super-abundance of rainfall of the tropics. Therefore, in these zones deeper planting to ensure a supply of moisture for the crop is necessary. Indeed, in these zones, especially in the more southerly parts of Australia with its heavy winter and light summer rainfall, reliance has to be placed on cultivation to conserve moisture precipitated in winter in order to augment the meagre rainfall during the season of the year in which the crop is grown.

For the average local conditions prevailing in Victoria, the best depth of planting is at 4½–5 inches. Under normal weather conditions, the maximum yields per acre are obtained from seed sown at about that depth. With machine planters, there is always a danger of planting the sets at too shallow a depth. The ridging done by the covering discs of these machines is apt to deceive the grower. If any difficulty is experienced in getting down to 4½ or 5 inches with the machines, a good plan is to precede the machine planter with a spring tooth cultivator set to full depth. By its loosening effect on the soil, this operation will permit the mechanical planter to bury the sets at the desired depth of 4½–5 inches.

Cutting Potatoes for Seed

The cutting of potatoes to be used for seed is essentially a question of economy. Where only large tubers are available for planting, it becomes necessary to subdivide these in order that they may provide a greater number of sets, and so keep down the cost of seeding per acre. In subdividing or cutting these, however, many growers go to extremes and slice up the tubers into pieces which are too small. Where this is done, the crop is handicapped at the outset. The question may be asked—What is the best-sized set? Before a direct answer can be given to this, several factors have to be considered. The first of these is the vigour of the seed parcel. Seed of weak constitution will not stand as much cutting as seed which has been selected out of a healthy and prolific crop.

Undoubtedly two of the main reasons for varieties of potatoes so quickly degenerating to a level at which their cultivation ceases to be profitable are that practically no selection of seed is made, and the seed used is too severely mutilated by the cutting knife. The second factor is the moisture content of the soil in which the seed has to be planted. Extremes of moisture and dryness are certain causes of "misses" when small-cut sets are used. Therefore, unless the soil is in a nice condition of moisture, either whole or fair-sized cuts should be planted.

A third consideration is the fertility of the soil. If the fertility and physical condition be good, the use of small-sized sets is permissible. The following comments and recommendations are based on the assumption that normally good potato land in a good state of tilth is to be planted, and that a parcel of potatoes made up of seed and marketable sizes is available for the planting.

In the first stages of the growth, the shoot or shoots produced from the seed set are entirely dependent on the nourishment they derive from the seed set. It is obvious then that larger sets can give a better start to the crop than can small sets, simply because they contain a greater amount of the essential nourishment for the first growth. In no circumstances should tubers of less than 1¼ oz. be used as seed for a field crop; in fact, seed of less than 1½ oz. weight should not be used if the soil and the seed are not in the best condition.

In cutting large tubers care should be taken to see, first, that at least one good eye is left on each section; second, that the sections cut are as uniform in weight as possible and not less than 1½ oz. in weight (so much the better if they are from 2½ to 3 oz.); third, that portions showing weak buds are discarded.

A fairly common practice of some growers is to rub off all sprouts which may be growing from the tubers at the time of planting. This

is a certain error. By doing so, the seed tubers are set back for some weeks in their growth, and are devitalized to the extent of the nourishment which they had expended in producing the destroyed shoots. It may be contended that the shoots are sometimes too long to permit the tubers being handled without breaking them. If the tubers have long shoots growing from them, they are merely giving ocular demonstration that the grower's system of storage is very much at fault, and this should urge him to the adoption of the system of storing his seed in proper seed potato boxes.

It is advisable that when cut the seed be placed in the ground as soon as possible. It is courting failure to cut and store it for some days before planting. The results of hundreds of tests prove that the seed planted on the same day as that on which it is cut gives the heaviest yield. Dusting lime, ashes, or sulphur on the seed to dry the wound caused by cutting is not necessary, as the ruptured starch cells quickly dry on exposure to air. Sulphuring at this stage may have some advantage, not as a drier but on account of its fungicidal action. In this capacity, however, it cannot be as effective as spraying the growing crop.

Provided that the tubers used for seeding are normally healthy and are cut into pieces of equal weight, no section of the potato has superior vigour to another, *i.e.*, stem ends and terminals are of equal value, weight for weight. The number of eyes on each set is of minor importance—it is the size of the set that counts.

Spacing of Rows

Not less than 12 cwt. of seed per acre should be used, and this quantity could, with advantage, be increased to 15 cwt. to 16 cwt. per acre.

For general practice, the spacing recommended is 27 inches between the sets in the rows. If planting is done at these distances, and 2 oz. is the average weight of the sets, approximately 16 cwt. of seed per acre will be required for planting. This is not too much. Experienced potato-growers have found that it is sound business policy to use fairly heavy ratings of seed per acre and to manure liberally.

Early varieties, such as Carman No. 1 and Manistee, may be placed 14 inches apart in the rows. In the case of late varieties, like Late Carman, Up-to-Date, and Snowflake, the spacing may be increased to 16 inches. The reason for these differences in spacing between early maturing and late maturing varieties is that the early varieties as a rule produce smaller topped plants, and do not require so much room for development as do the large topped late varieties.

During the past twenty years, the writer has judged many field crops throughout the State, and has found almost invariably that the winners on points of quality and weight of tubers have been growers who practised close planting. The results obtained from trials conducted some time ago by the Ministry for Agriculture for North Ireland so emphatically confirm the soundness of the practice of close planting, which has been very strongly recommended by this Department, that they are worth quoting here. The test was carried out on three plots, for two years, the sets being planted at distances of 10–15 and 20 inches apart in drills 27 inches wide. The results were as follows:—

	tons	cwt.
10 inches between sets	16	17 per acre.
15 inches between sets	13	4 per acre.
20 inches between sets	11	19 per acre.

A feature decidedly in favour of close planting was that the tubers produced were invariably more uniform in size and shape and more attractive for marketing purposes than where thinner planting was adopted.

While it is not advocated that, in general, potato-growing in Victoria, potatoes should be planted so close as to allow only 10 inches between sets in the rows, this spacing could be approximated with advantage by growers for the earliest market (about August-September). These very early crops are generally grown in soils of a light character—sandy to loamy soils—which are fortified, either naturally or artificially, to a high standard of fertility. The higher the fertility of the soil in which the potato crop is grown, the closer the planting should be. For late crops grown in heavier soils, planting should be at wider spacings, on account of late varieties growing large tops, and consequently requiring more room for development. The practice common amongst growers of late varieties, however, of spacing out their sets to 18, 20 and even 24 inches between them in the row, is merely waste of ground. There is no justification for wider spacing than 15 or 16 inches between the sets of late varieties. A distance of 27 inches between the rows, which equals 29 rows per chain, has been proved to give ample room for horse cultivation in the heaviest ground, and this could with advantage be reduced to 26 or even 25 inches on fairly level country of medium to light texture.

Planting in Irrigation Areas

In irrigation districts, planting behind the plow is best. If dry, it is advisable to irrigate first, then cultivate and harrow as soon as possible, then harrow immediately after planting to conserve moisture. Plow plant, and harrow each half day's planting before leaving.

Never leave planted furrows open at lunch hour or overnight. This is possible with single or single and double ploughs working in conjunction. Do not leave the furrow to be planted open, but plough a seed-covering furrow and leave the planting furrow to be opened fresh after lunch or at the morning renewal of planting operations.

Varieties

(About 58 varieties of potatoes have been described as being grown in Victoria.)

No. 8.—Inter-Cultivation

There are important reasons why the soil should be cultivated after planting and during the growing period of the crop. First of these is the fact that well-cultivated soil is capable of absorbing and retaining moisture to a much greater degree than soil which is compact or hard.

The second important effect of inter-cultivation is that the physical conditions of the soil is maintained at a good standard, thus permitting a sufficiency of aeration to take place. This has the effect of promoting the action of beneficial bacteria, which break down insoluble plant foods in the soil and make these available as food to the plants.

Further, by improving the mechanical condition, inter-cultivation permits freer root ramification and extension in search of the elements, of fertility. Good mechanical condition, too, has a very large influence on the shape of the tubers. In hard or compact soil the tuber, when increasing in size, meets with restriction which causes deformity of the natural shape of the particular variety grown. In well-cultivated soil, however, the tuber is free to expand without restriction, and so develops to full size with more perfect shape. The last principal effect of inter-tillage—and not the least—is that foreign plants or weeds are kept in subjection or entirely killed—thus permitting the crop to benefit to the full extent from the plant food and moisture content of the soil.

Methods of Cultivation

Harrowing is the cheapest form of cultivation utilized in agricultural practice. By its employment, a large area of ground can be cultivated to a shallow depth in the course of a day at very small cost per acre. Because of the cheapness of this method of cultivation, potato-growers should utilize it whenever practicable in order to keep down production costs.

After planting, and until the crop is well up in the rows—even to a height of 4 or 5 inches—effective work in preserving good surface tilth can be done by harrowing at frequent intervals of, say, one week. In the event of rain falling during this early stage of the crop's growth, the harrows should be used as soon after the fall as the ground is in

working condition. This will prevent caking, or baking, of the top, and help to conserve the moisture.

Frequent harrowing at this stage is an excellent and economical means of killing off weeds as they germinate, and, if done systematically will eliminate the necessity for much weeding later on. Once the plants reach the height of 4 or 5 inches, subsequent cultivation, up to a time when they are about in full bloom, must be confined to the horse-hoe, an implement designed specially for cultivation between the rows of any growing crop. It is capable of being adjusted in the width and depth of cut to suit the requirements of any stage of growth of the crop.

This implement is now procurable for operating in one, two, or three rows at a time, the double and treble row cultivators being most suitable for large areas. The three-row horse-hoe can be worked in the majority of soils by two horses controlled by one man—whereas, with the single-row horse-hoe, three men and three horses would be required to cover the same ground in an equal amount of time. Owing to the wide variations of soil textures and seasonal conditions, it is not possible to set down any hard and fast rule as to the number of horse-hoeings that should be given to the crop, but it may be safely advised that there should not be less than two to three during the season. The intervals of time between the hoeings will vary with the seasons and the rate of growth of the crop, but the interval between each horse-hoe cultivation should be about a fortnight.

One point that can be strongly advocated is that opportunity should be taken to use the horse-hoe as soon after rain as possible, the objectives of course being the reconditioning of the tilth and the conservation of water.

The first hoeing of the season should be done at the greatest depth at which the team can manage the implement and at as wide a distance as possible without unduly disturbing or damaging the plants on either side. Each subsequent hoeing should be at a narrower width and a shallower depth in order to accommodate the cultivation to the increased growth of the plants. If the season permits an approximation to these suggested times of hoeing, the plants normally should be just coming into full bloom by the time the third cultivation is given.

Weak and Foreign Plants

At this stage, opportunity should be taken to go through the crop in order to remove any obviously weak plants and destroy them, as not only are they non-productive and unfit for use as seed or for consumption, but they are also potential carriers of disease to a succeeding crop.

Rogueing, or the removal of plants not true to the variety supposed to be grown, should also be done. It is only at this stage that an accurate judgment can be made as to whether the whole of the plants growing are of any particular variety. When in full bloom, the foreigners to the variety desired can be observed at a glance by the colour of the flower, or by the character of haulm or by the peculiarity of the leaf shape or its structure. Later, it is most difficult, and, in some cases, almost impossible to distinguish certain varieties from each other.

The growth of pure parcels of any particular variety is most desirable. Where varieties are mixed, yields are often lessened owing to the differences in the period of maturation. Rogueing at this stage is a profitable operation, particularly when it is intended to market the produce as seed. Seed parcels of mixed varieties have a comparatively low cash value. Parcels of seed, which are pure, command a figure always above current market prices. The sale of seed is the most profitable of the potato trade, and rogueing the plants which are in bloom to eliminate strangers is one way to get a share of this extra profit.

Hilling

The next operation in inter-cultivation is the hilling or moulding up of the plants in the rows. This is advisable for two reasons, the first being that it saves the tubers formed near to the surface from being scalded by the sun or greened by the action of light. Tubers greened by exposure are unfit for consumption, being bitter to the taste and mildly poisonous, owing to the development of solanum. Cases are on record where stock have died from being fed on greened tubers.

Another very important result effected by hilling is that the tubers are protected from attack and damage by the grub of the potato tuber moth (*Lita solanella*). In a hot dry season favourable to the rapid increase of the moth and grub, a crop which is unprotected by hilling may be riddled in less than a week by these grubs. Good hilling, combined with good tilling, is a safeguard against loss from this source, up to the point of digging.

A further benefit from hilling up the crop is that digging, either by machine or hand, is facilitated as the machine or fork can be projected with greater ease to a depth slightly below the level of the deepest tubers, and there is less damage to the tubers.

Inter-Cultivation under Irrigation

Inter-cultivation is perhaps the most important of all operations connected with the growth of potatoes under irrigation. After the planting and harrowing operations described have been completed,

the land should be harrowed frequently, to maintain a nice tilth. Local conditions will determine the frequency of this operation, but on no account must setting of the surface soil be allowed to take place.

Harrowing may be continued until the plants are 4 or 5 inches high, after which recourse must be had to inter-cultivation in the rows by the use of a one-, two-, or three-row horse-hoe. The usual practice is to use a one-row horse-hoe, which is sufficient for small areas, as it is capable of getting over from 3 to 4 acres per day. In the early stages of growth, when the plants are small, this implement should be set to cultivate the deep and wide, *i.e.*, close up to the plants in the rows. Each subsequent inter-tillage should be given with a progressively decreasing depth and width, so that the growing plants may not be injured at the roots. The horse-hoe should be used frequently between irrigations, and as soon after irrigations as the ground will permit working.

Irrigating

In practice, from 5 to 8 chains is the most effective length to run the irrigation water. The lighter the soil, the shorter the lands should be. Presuming the season to be quite dry, under average conditions, it will be found necessary to irrigate about 3 to 4 weeks from the date of planting. At that time the plants from sprouted seed should be showing well up in the rows and their foliage commencing to spread. Prior to irrigating, the horse-hoe, with the hilling attachment or broad tine adjusted, should be run through the rows, and the soil on either side thrown up on the rows, but not sufficiently high to cover the plants. This facilitates the application of water. Care should be taken not to commence irrigating until there is a good "head" of water on hand, as without this the irrigator has but poor control over the regulation of the supply. The water should *never* be allowed to flow over the tops of the rows, but should be confined between the drills.

The flatter the land being irrigated, the greater the flow of water it can take within a given time. The greater the fall, the less the flow that can be taken in the same time. Being less permeable, clay loams should be irrigated at a slower rate than light sandy soils. Individual growers must study their own conditions closely since only in this way can one determine the methods most likely to give him the best results.

In a season without rain, subsequent irrigations will be required at intervals of about three weeks. The final irrigation should be given not later than when the plants are just going off the bloom. Cultivation and hilling up should then be completed and the crop allowed to mature without further cultivation. It is of importance that cultivation after each irrigation be given as soon as the ground is fit to work, and that the area be then hoed as quickly as possible.

Excessive application of water will produce tubers of very low table quality, induce rotting in the field, and prevent adequate cultivation.

Irregular or insufficient application of water will cause a poor yield, and large percentage of second growth. The potato crop requires continuity of moisture without excessive wetness. Given that, the irrigation districts, because of their arid atmospheres and high potash soil content, can produce potatoes of the very finest table quality.

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